JULY 1984

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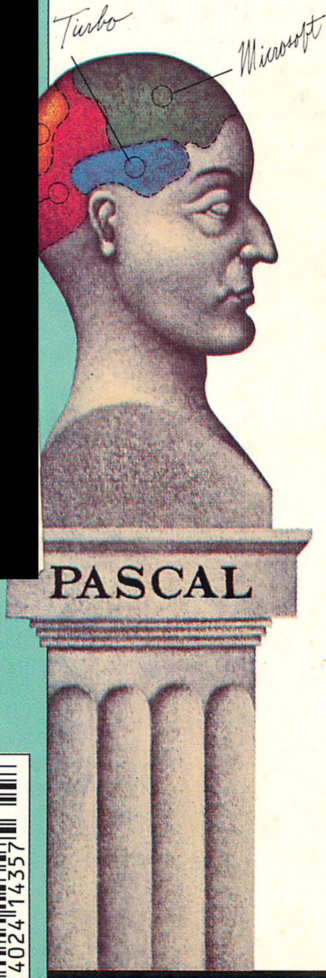
FOR IBM PERSONAL COMPUTER USERS

TECH JOURNAL

FOUR PASCALS FOR THE IBM PC

Rating compilers from Borland, DRI, Microsoft, and SBB

[redacted]



RESEARCH REPORT: DATA MODELS

COMMUNICATIONS REVIEW: CROSSTALK XVI

MODEMS DEMYSTIFIED

MATHEMATICAL MODELING ON THE IBM PC WITH TUTSIM

STRUCTURED BASIC

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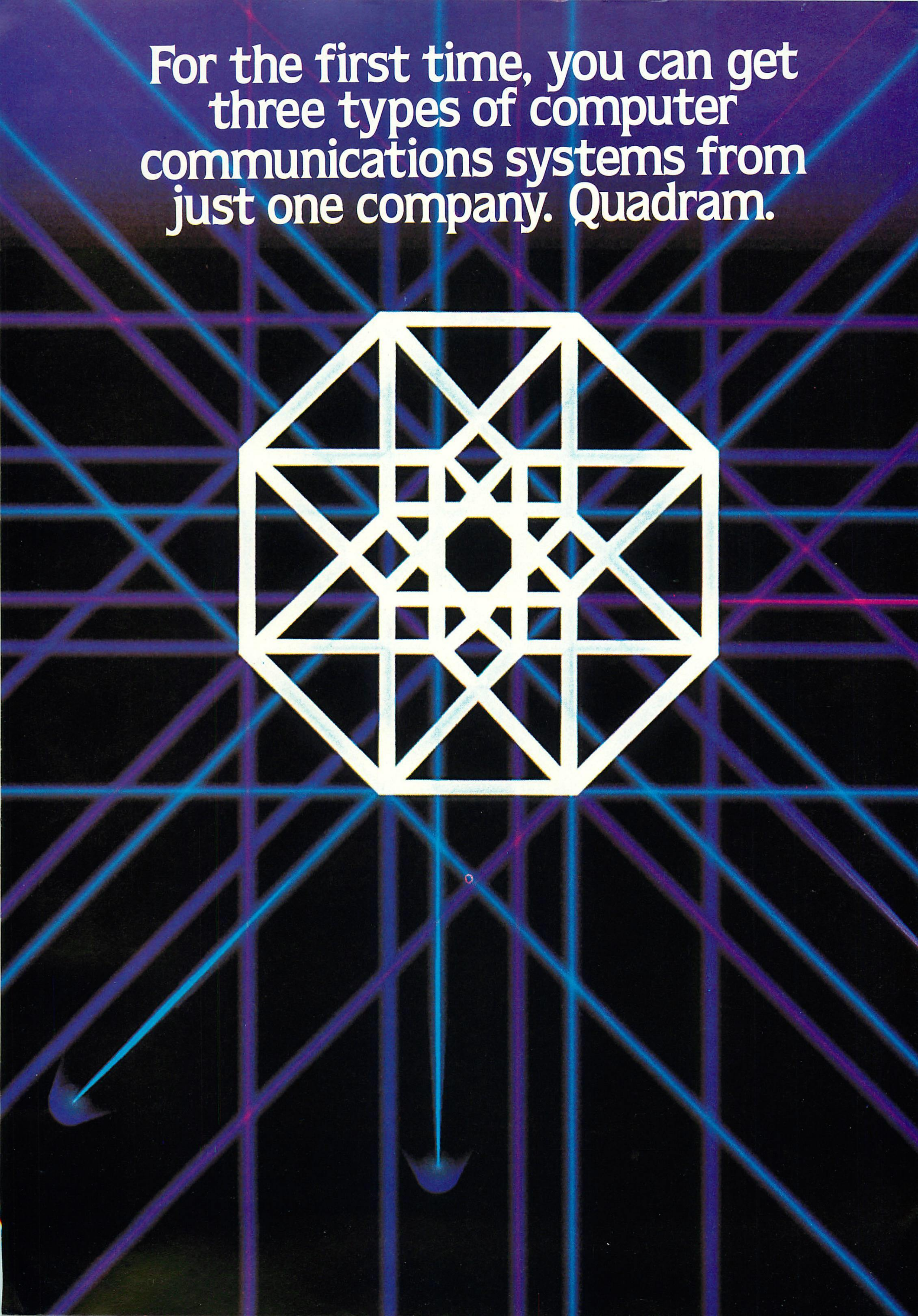
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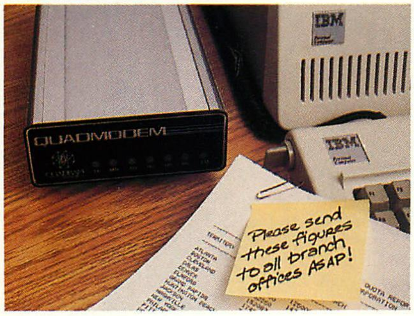

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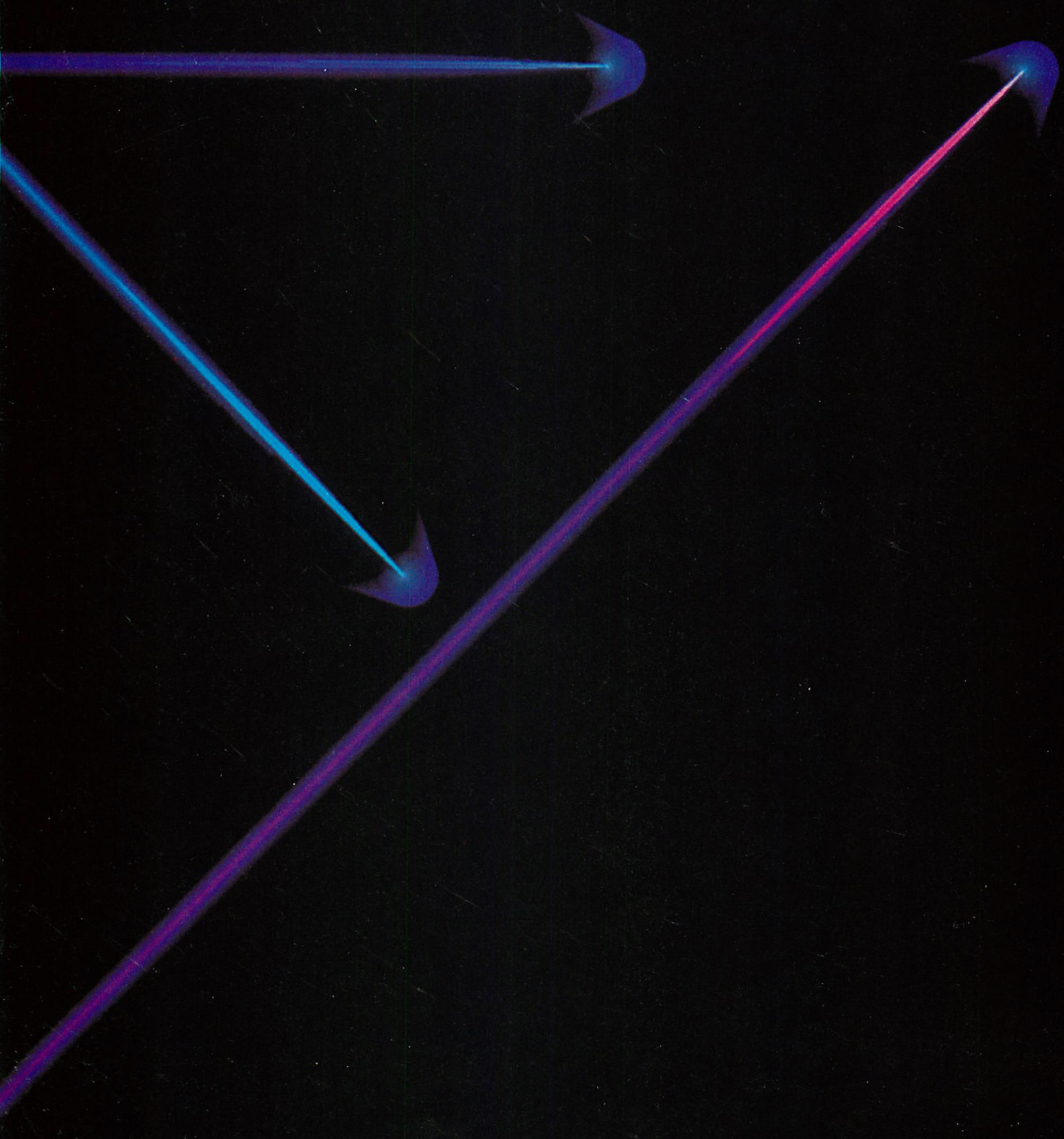

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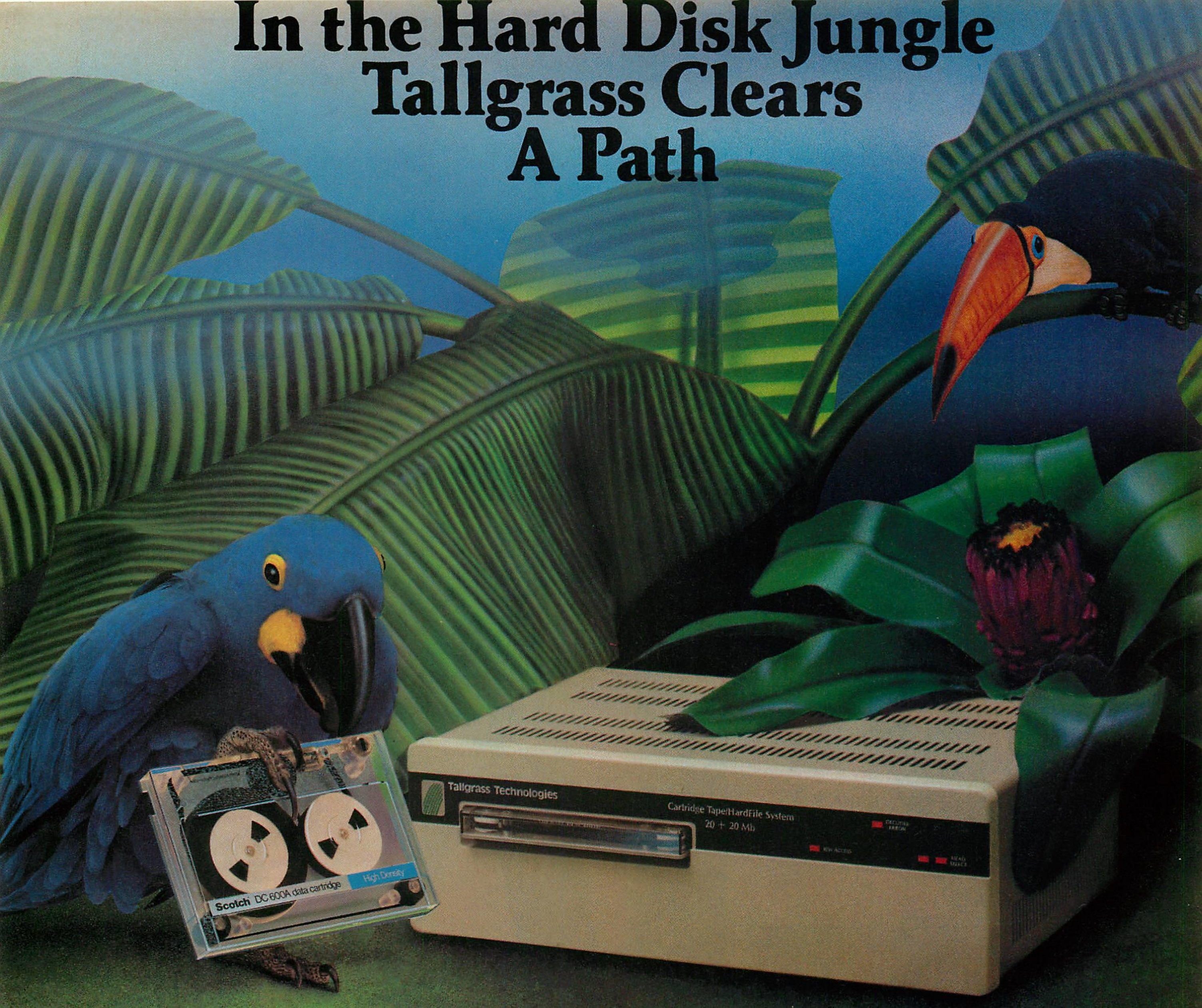

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FOR IBM PERSONAL COMPUTER USERS

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TECH JOURNAL

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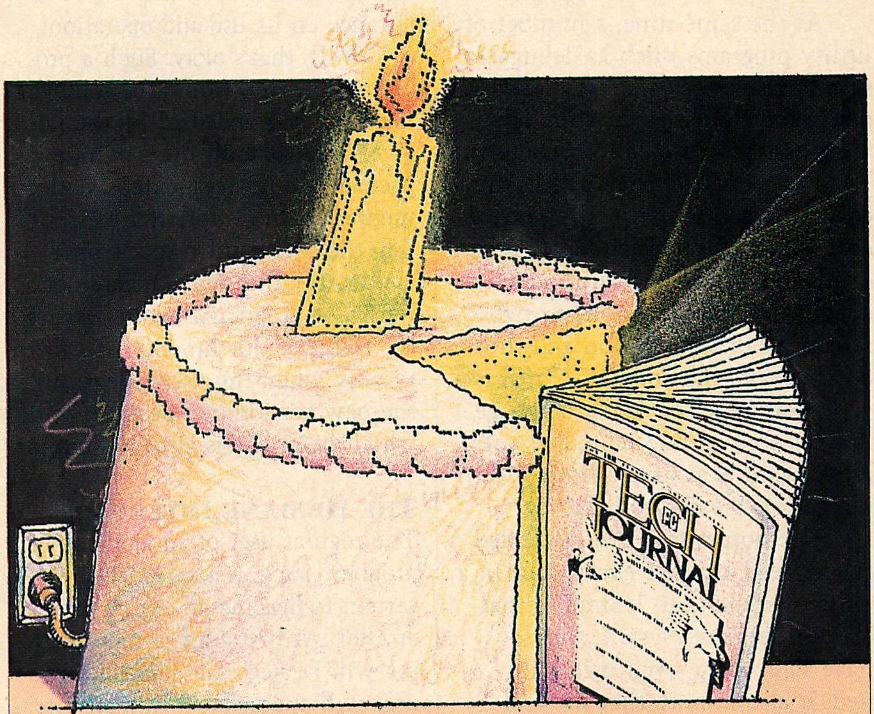
Help!

The rush to on-line help sometimes loses users in the dust



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We have been most gratified by your response to our first year; our warmest thanks go out to the ever-increasing numbers of readers and the continued strong support of advertisers. A resounding *Thank You!* is due our many friends and associates within Ziff-Davis without whose creative magic this magazine would never appear.

In my first editorial, I asked whether the world needed another magazine about the IBM personal computer, and then boldly answered, yes, it did. But clearly the key to *PC Tech Journal*'s success is that it is not just another magazine in the IBM field, it is the single source for detailed, exacting information about the complex technical issues that surround the PC. The best part is that the more we understand, the more we need to know. We're having the time of our lives figuring all this out.

Stay tuned. —*WF*

One facet of desktop computer software that has improved dramatically over the past two years is on-line help. Even so, help facilities themselves are still in need of help.

On-line help is the assistance provided by an application program to help users understand its operation or use. For example, WordStar provides menus that describe most of the keystrokes available at the moment; these menus change as the general context changes, usually as the result of a keystroke calling for a special subset of features. The original version of VisiCalc had terse menus that changed at every keystroke and provided a continuing roadmap of the features and options available at every point. These two programs are singled out because they are examples of two different kinds of on-line help, and because they were the first widely circulated programs for desktop computers that had such support.

Those early techniques, seemingly mandated by limited hardware resources, were soon eclipsed by the help facility of a new spreadsheet product: SuperCalc. What Sorcim did had been done before on minis and mainframes. But SuperCalc was the first commercial program for micros that offered context-sensitive help, a compelling feature in those days.

Since then, context-sensitive help has been the preferred style of on-line support for users, and rightly so. Assistance in the context of the immediate problem is the ideal way to keep novice users on track and to reduce dependency on the instruction manuals. Most of the contemporary spreadsheets have such facilities, and other major applications have similar features.

But what has also happened is that just about every program claims to have help to one degree or another. This is where the problem begins to emerge: some of that help is just not what it's cracked up to be. So here follows a quick guide, for developers and users alike, to the types of help systems that are most common, as well as some advice on what is practical for various types of programs.

NO HELP AT ALL

In some applications—programming languages and other programming tools, for example—an interactive

help facility is not practical. Most of us would agree that a C or Pascal compiler is not obliged to provide users with detailed assistance. It is reasonable for UNIX to have a utility program state its proper usage if a command line is incorrect, but that's about it. A programming language is an *expert's* tool and as such should have no excess baggage.

At the same time, a number of utility programs, such as debuggers, should provide, at the very least, an on-line reference card. Although users can be expected to become experts in the use of such a tool, they can easily forget the spelling or precise syntax of an infrequently-used command. Reference cards usually contain no more than one or two screenfuls of information and thus do not waste memory. PC/Forth is a good example. The Forth language itself has no on-line help, but a reference card is available from within the editor. It's a good balance.

The notion that even experts might need a nudge every once in a while is important. It implies that every interactive system should have some help, even if it is limited. It also implies that the tool need not teach and that users have some prior knowledge.

Menus

The menu type of human interface is attractive because it is simple to comprehend and use and equally simple for program designers to include. Menus carry a considerable amount of *help*ful information. They are, in effect, a help system built into the human interface and thus carry the advantage of being always present. What gives menu systems a bad name is that once users understand the program, they see the helpful information as just so much excess baggage.

The Expert Interface

VisiCalc was an important prototype for the expert user. The idea was that some prompting would occur to remind the user of the next steps, but no deeper information would be provided. There is a valuable concept here: the user is helped by being told what the options are at every step, but he must understand, in advance, *what each option is.* In other words, the user must become adept at using the system before the system can give assistance on its use and operation.

Well, that's okay. Such a program, however, cannot be removed from the box and used by the novice. Because most users of a new package are novices, extensive documentation and tutorials are essential; the user must commit time and energy that may or may not represent productive work. Expert interfaces of this kind are satisfactory only when the user is learning the new version of a program with which he or she is already familiar.

The Humane Interface

The regular user of an application program, such as a spreadsheet, is certain to become an expert sooner or later. At first a lot of handholding will be necessary but later the user will appreciate a human interface that is quick and responsive. That means help cannot be omnipresent, as in the menu system, but nevertheless must be simply and quickly accessible.

The first program I have seen that really satisfies these criteria is SuperComp, from Access Technology. SuperComp, a spreadsheet that is now available on micros, was first introduced on minis. Its interface was expert, resembling VisiCalc's, and its help system was context-sensitive to an even higher degree than SuperCalc's. More importantly, the help system provided references to related topics and a direct link to a help screen on those topics.

This facility would help in many situations. For example, it would solve a problem I often have: I know that SuperCalc includes a COUNT function, but I can never remember whether it counts the total number of cells in the range or only the non-blank ones. So I'm in the middle of a formula, having just typed a slash for division (to get an average, for example), and I ask for help. SuperCalc gives me a list of all the functions. Good, there's COUNT, but how does it work? Wouldn't it be nice to trip the cursor down to COUNT and hit the HELP key again? I don't need long explanations, I just need that little nudge.

MultiPlan is similar to what I have described here. It is basically a menu system without the typical bulk of menus and therefore without visible, helpful information. The user moves a cursor to one of the options and selects it; options can also be selected just by striking the first letter of its name. For help, however, the user moves the cursor to the item in question and hits the HELP key, whereupon the program displays specific information about the option. It's quite a combination.

So What's Wrong?

Users want help, so the manufacturers give it to them in one form or another and include it in their sales pitches. But this does not mean they are delivering a help system that is matched to their type of program and to the requirements of the users. Users should be aware that a demonstration of a help facility by an expert can be just as misleading as a demonstration of the rest of the program by the expert. Knowing what to buy here is extremely important.

By the same token, developers (of both commercial and in-house products) should include a help facility from the outset of a program design. Attempting to add it later is almost a guarantee of failure.

As difficult as it is, the humane interface is almost always the most desired and most appreciated by the ultimate authority, the end-user.

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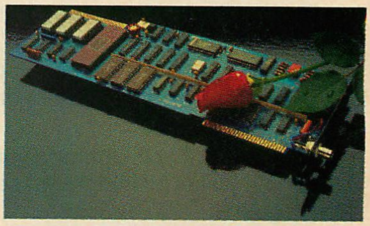

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MAGNUM MEMORY						✓				✓	✓
MINI-MAGNUM	✓	✓	✓	✓	✓	*	*	✓	✓	*	*
MAGNUM 10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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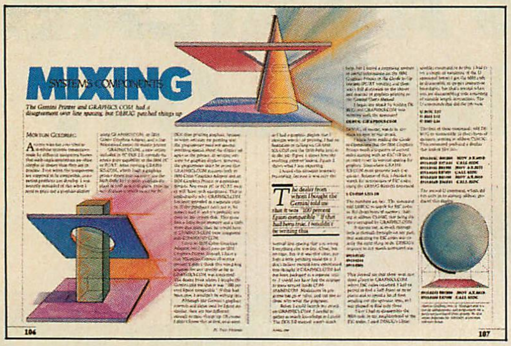

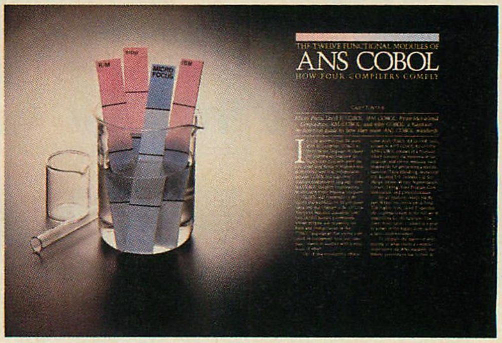

A Hex on Gemini

"Mixing Systems Components" (Morton Goldberg, *PC Tech Journal*, April 1984, page 106) was a good article for all Gemini printer users. However, hexadecimal and decimal representations got mixed up in the DEBUG E(nter) commands that were given in the article. The correct values should be

E CS: 0169 10

E CS: 0250 18

Perhaps a quick explanation of the vertical spacing will help. The Epson vertically spaces in increments of n/216 inch. So for the spacing of eight points (72 points per inch), we use

24/216 = 8/72 (the hex value of 24 = 18H).

For a spacing of 12 points we use

36/216 = 12/72 (the hex value of 36 = 24H).

The Gemini printer vertically spaces in increments of n/144 inch. So for a spacing of eight points we use

16/144 = 8/72 (the hex value of 16 = 10H).

For a spacing of 12 points we use

24/144 = 12/72 (the hex value of 24 = 18H).

A. Heimlich
Santa Clara, CA

Cobol Comments

Thank you for your comparison of COBOL systems for the IBM PC ("The Twelve Functional Modules of ANS COBOL: How Four Compilers Comply," Casey Pontius, April 1984, page 76). I would like to point out some minor corrections in the information that was included about mbp COBOL.

Contrary to the article, mbp COBOL *does* support Line Sequential organization; it is, in fact, the default. The article also noted another COBOL as allowing external file-name literals to be present in the COPY statement; mbp COBOL supports the same function.

Furthermore, the January 1984 release of mbp COBOL includes several extensions noted as pluses for other systems. Your readers specifically might want to know about our new SORT capability, CHAIN extension to Inter-program Communication, and extensions to ACCEPT and DISPLAY verbs.

As a reference report the article was very rigid in its attempt not to show more than ANS COBOL-74 comparisons. We were very surprised, however, to learn that such reference reports do not include prices. A simple cost comparison would quickly show that mbp COBOL offers more than most at as little as 25 percent of the cost of some (as reviewed, that is).

Thank you again for the review. We look forward to other COBOL-oriented articles in *PC Tech Journal.*

Gerald E. Weltner, Jr.
Vice-president
mbp Software and Systems
Oakland, CA

We regret our omission of features supported by mbp COBOL version 6.12. Also, because of our editorial deadline, we were not able to report on the extended features of version 7.04, but we plan an in-depth review of each of the four COBOL compilers available for the IBM PC. Pricing information on these four compilers is listed below.

RM/COBOL v1.5
Ryan-McFarland Corporation
609 Deep Valley Drive
Rolling Hills Estates, CA 90274
213-541-4828
$950

IBM COBOL v1.0
Microsoft Corporation
10700 Northrup Way
Bellevue, WA 98004
206-828-8088
$700

MICRO FOCUS LEVEL II COBOL v2.1
Micro Focus, Inc.
2465 East Bay Shore Road
Suite 400
Palo Alto, CA 94303
415-856-4161
Level II (High Performance): $1,595
Level II (Compact): $795
Animator: half price of compiler
Forms II: $195

mbp COBOL v6.12
Software & Systems Technology, Inc.
7700 Edgewater Drive
Suite 360
Oakland, CA 94621
415-632-1555
v6.12: $500
v7.04: (with SORT and CHAIN) $750

—JA

Thank you for publishing Casey Pontius's excellent research report on ANS COBOL and four compilers' compliance to it. I spent much of 1983 testing the four compilers listed in the article.

Unfortunately, for anyone looking for guidance about which product to purchase, the article was not very enlightening. Compatibility to ANS COBOL standards should be only one of many variables in determining which product best meets an individual's needs. Of course, when lack of compatibility reaches the extent of the Microsoft compiler, it does become enough reason to flush the product, which is precisely what I did with it.

Some of the variables that a prospective buyer should consider are:

- Is the product a true compiler, or is it a glorified interpreter requiring numerous "calls" to a run-time library file at execution?
- Is the product complete? Does it include all the programming tools nec-

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6. Nested command files
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Hardware Requirements (where you can save hard cash)

IBM PC or XT (or compatible)
256K bytes of RAM
2 Disk Drives—Hard or Floppy

Since X-shell can be run using floppy disk drives, you can save a bundle of money on your hardware. Hard disks are expensive. Floppies aren't. It's that simple.

Software Requirements

PC-DOS version 1.1 or 2.0
Software Disk Emulator

Since X-shell runs on PC-DOS, it supports existing PC-DOS software.

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X-shell's commands include:

basename	–strip extension from file name	**num**	–number lines
cat	–concatenate files	**pr**	–format files for printing
cd	–change directory	**print**	–pr directed to printer
clear	–clear monitor screen	**pwd**	–print working directory
cmp	–compare files	**rm**	–remove files (delete)
comm	–output lines common to two files	**sh**	–shell (command interpreter)
cp	–copy files	**size**	–size of object code
cpio	–file backup/archival	**sort**	–sort numerically or alphabetically
date	–get or set date and time	**sum**	–checksum file
echo	–echo arguments to stdout	**tail**	–output last lines of file
expand	–expand tabs into spaces	**tee**	–pipe fitting
expr	–string and arithmetic evaluation	**test**	–test file's or string's characteristics
false	–do nothing, unsuccessfully	**time**	–determine time to execute a command
find	–produce list of selected files	**tr**	–translate or delete characters
grep	–search files for specified pattern	**true**	–do nothing, successfully
hd	–hex file dumper	**unexpand**	–replace spaces with tabs
head	–output 1st lines of file	**uniq**	–remove duplicate lines
ls	–sorted directory list	**wc**	–count chars, words and lines
more	–copy files to display	**words**	–output file 1 word per line
mv	–move files (rename)		

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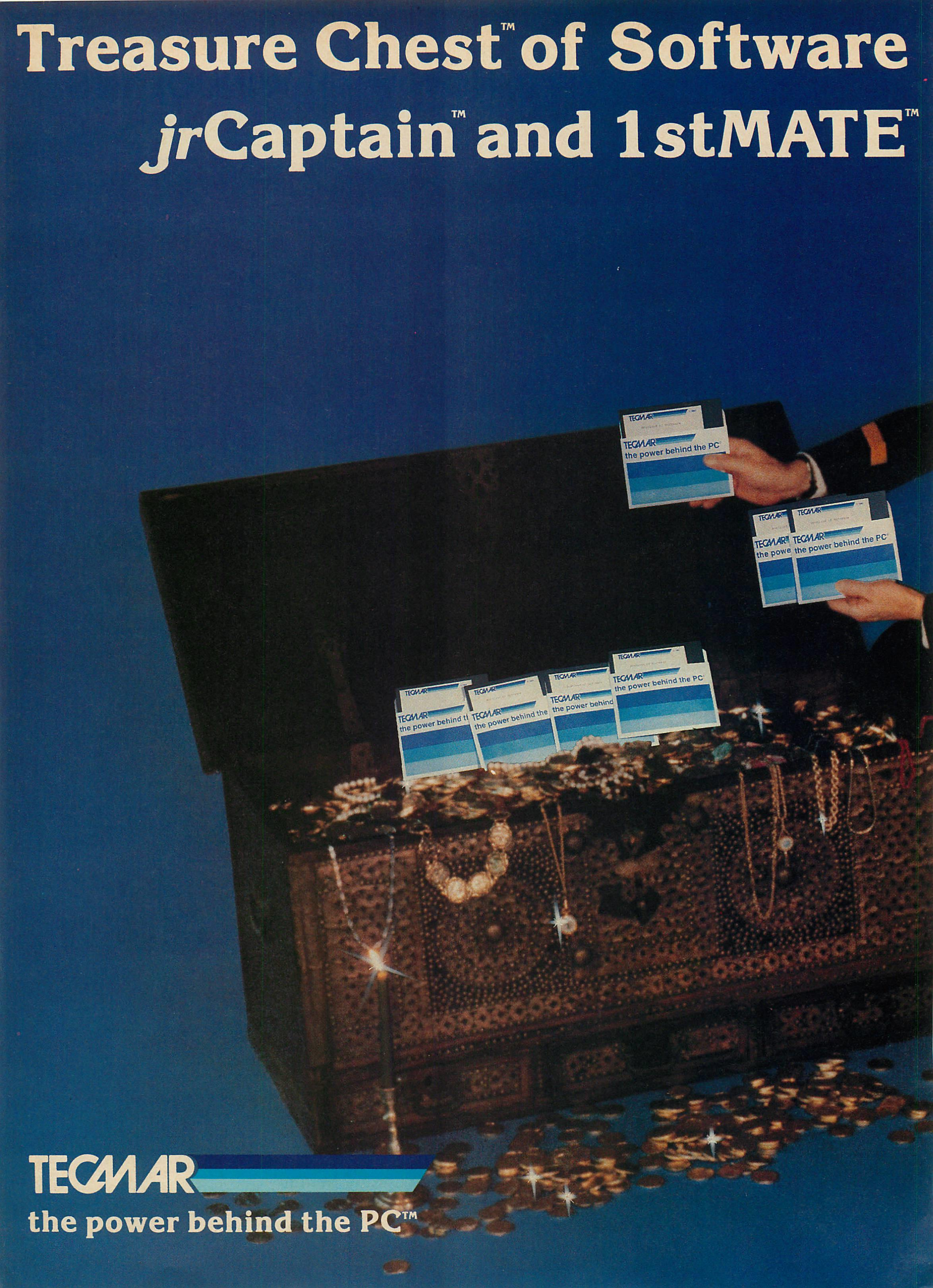
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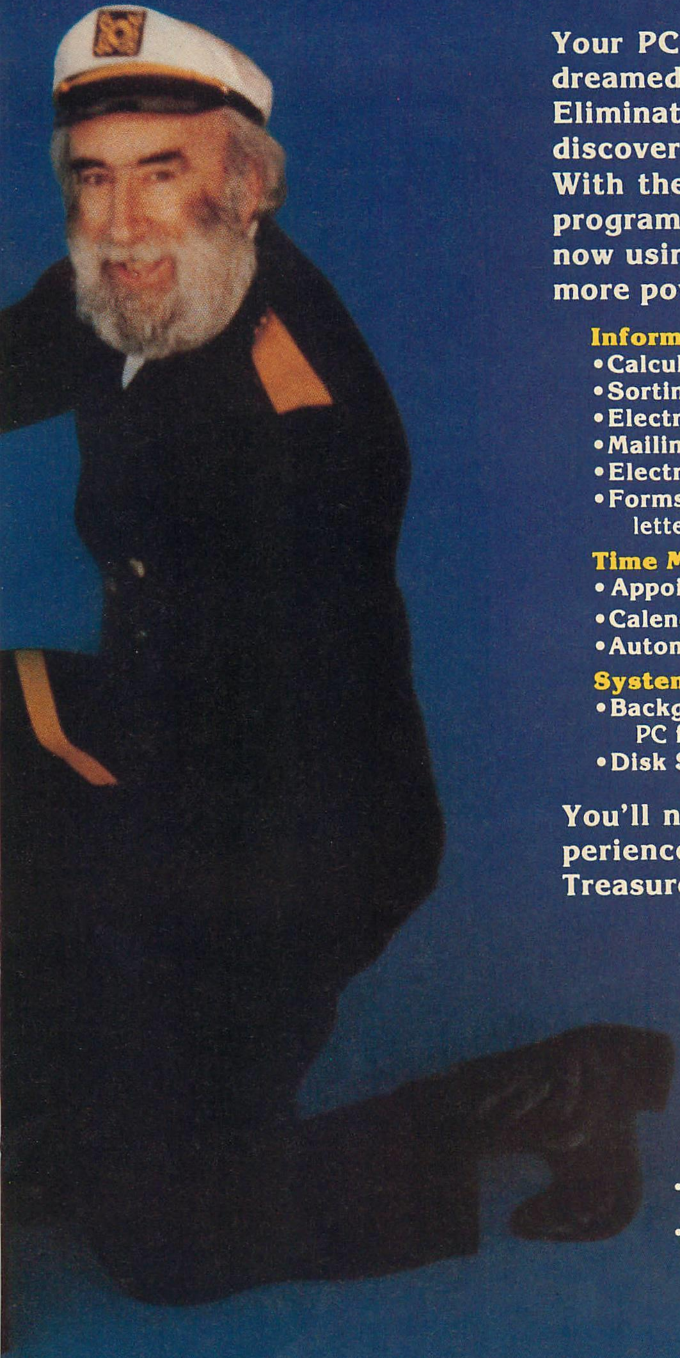

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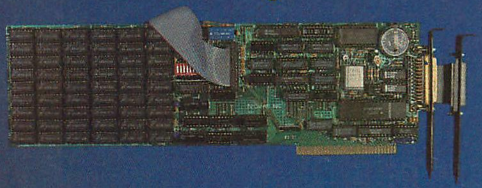

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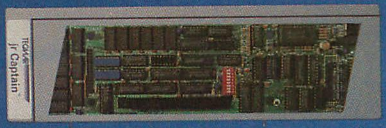

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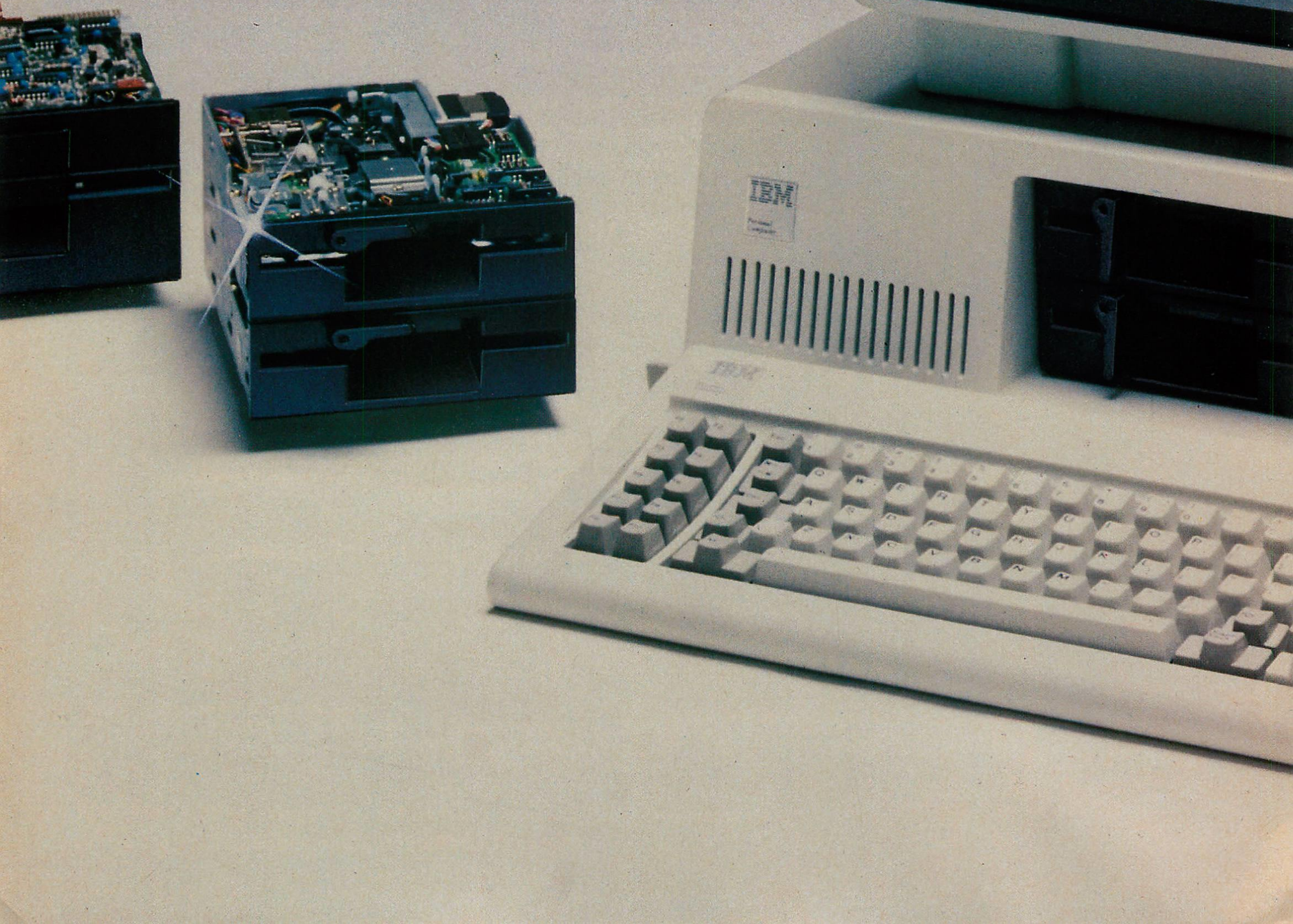


IBM
IBM

essary, or will it have to be supplemented by other products—i.e., screen generator, interactive debug module, various listing options, etc.?

- How compatible is it to mainframe code? Does it require imbedding PC specific code (for example, screen handling, file assignments) in programs, or does it maintain the integrity of the mainframe code?
- What is the quality of the vendor's technical support?
- Is the product well designed, programmer friendly?
- And, of course, price.

I certainly could have used this article a year ago; it would have provided a good starting point for my study of COBOL compilers for the PC.

Mark Sundermann
Sr. programmer-analyst
Connecticut Mutual Life
Hartford, CT

MIND EXPANDING

The articles by Peter Aitken about the PC and Tecmar Lab Master Board ("Passing the Lab Test," January 1984, page 75; and "Digital-to-Analog, Analog-to-Digital," March 1984, page 104) have been very useful.

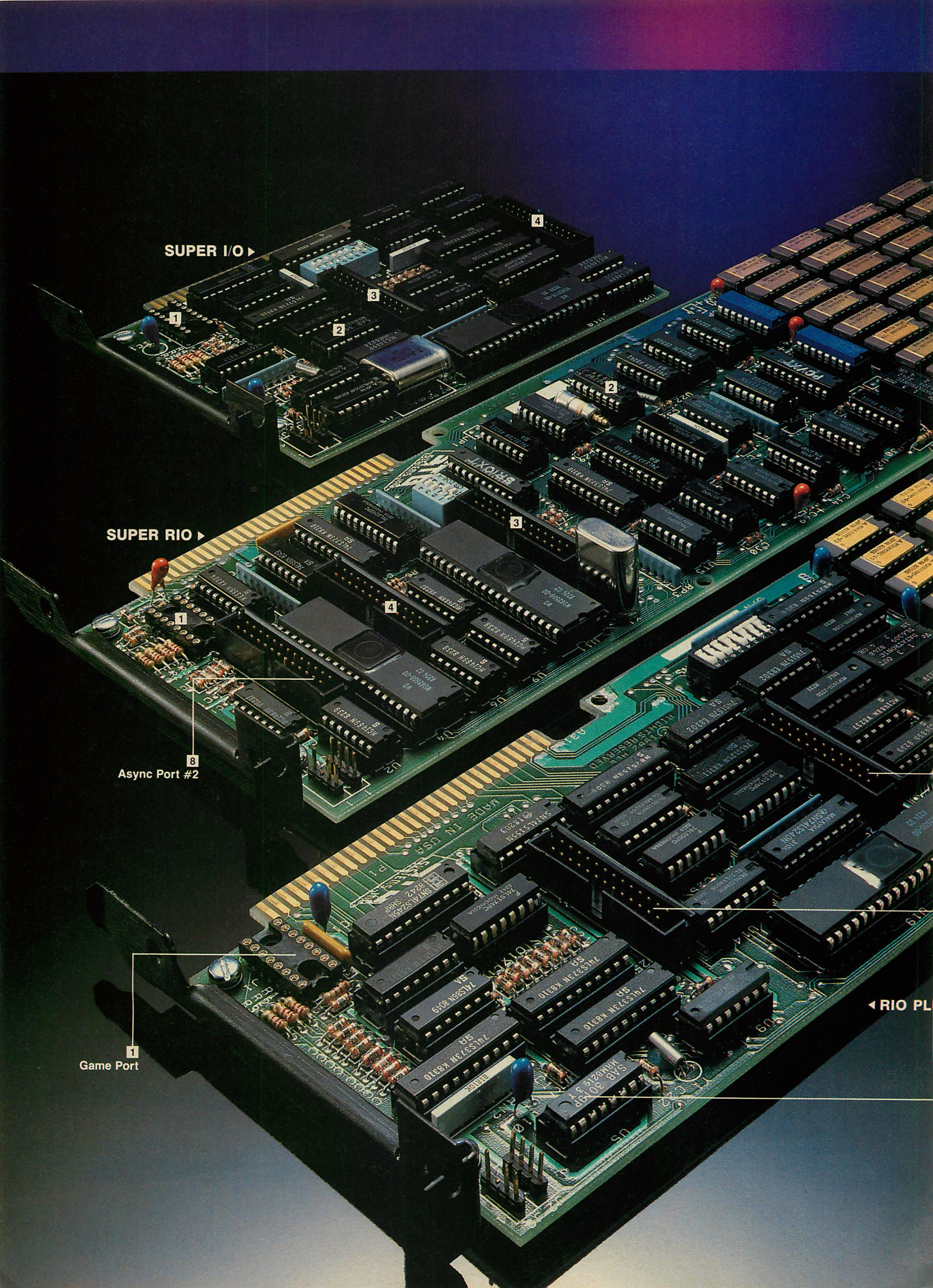
I enjoy reading and studying *PC Tech Journal*, and I especially appreciate articles explaining the use of expansion boards, particularly if assembly routines are shown.

Casey L. Haake
Minneapolis, MN

TERRIFIC TOOL TROIKA

Good tools are hard to find, so I was glad to see Blaise Computing's Pascal Tools finally get some press in *PC Tech Journal* ("Pascal Tools Review," Arthur Gleckler, February 1984, page 161). However, the editor's note that Pascal Tools 2 had recently been introduced but was not available for review struck me as odd. My copy of Tools 2 dates back to July 1983. Does it really take seven months to write a software review? View Manager, an extremely important tool from Blaise, was not mentioned at all. We have found this triad of tools far and away the most powerful, best supported, and accurately documented of any now available.

Anyone who is working in Microsoft Pascal under DOS 2.0 without Tools 2 is reinventing the wheel. Blaise Computing's Tools 2 package gives the application developer access to the full power of input/output redirection, program chaining, memory management, and directory maintenance from within the program.


SUPER I/O ▸
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8
Async Port #2
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◂ RIO PL

The third member of the troika is equally as important. How many times have you dreamed about a fast screen printer that could read in data and do user-input error checking? What about help screens that flash up in one second? View Manager has this and much more, including a fully enabled screen data-base manager, editor, and documentation generator.

We have saved thousands of dollars using the Blaise Pascal Tools and I can happily recommend them.

P. Adrian Z. Calta
Washington Programming Team
Washington, D.C.

Upgrade Concerns

As a subscriber to your magazine since the first issue, I commend you on providing good technical information that is valuable to the personal and hobby class of user. I especially enjoyed "Upgrading a PC to an 'XTRA T' " (Susan Glinert-Cole, February 1984, p. 75).

I originally owned Z80 S100-type hardware. I have now disposed of this equipment and am considering the purchase of a PC or XT. My personal computing and hobby activities don't require eight card slots or a hard disk. However, I would like to have a greater transfer rate and capacity than the standard PC disk drives provide.

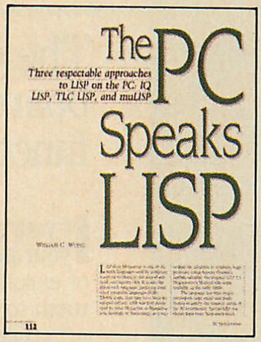
Therefore, I am considering purchasing a PC with only one drive, then placing two half-height drives in the remaining drive location. The half-height drives would be the type that can be formatted to hold 2.5 megabytes using the JFORMAT program. I would add a multifunction board with additional memory used as a solid state drive to provide the higher transfer rate I want when processing.

My concerns for this approach are: (1) Will the PC power supply support two such half-height drives without overloading it? (2) Are the half-height drives reliable when formatted to contain this much data? (3) I understand that the PC motherboard has 64K less ROM space than the XT. Is there a difference in system capability because of the smaller ROM capacity—or is it just less space available for user ROM?

Robert W. Watts
Salem, OR

The PC power supply should support your half-height drives without overloading it, although it depends on the specific unit. Whether or not the drives would be reliable when formatted to contain 2.5 megabytes is uncertain. It depends on the quality of the drives and the quality of the media. In answer to your third question, ROM capacity is not so different in the PC and XT. PC ROM space is 5 ROMs by 8K, or 40 KB. One 8KB ROM socket is empty. The XT has 2 ROMs by 32K, or 64 KB of ROM space with no empty sockets.

—WF



Late With LISP

I have just read the review of three LISPs in your April 1984 issue ("The PC Speaks LISP," William G. Wong, page 112). The reviewer seemed to know his stuff.

It is inexcusable, though, that muLISP-82, an out-of-date version of muLISP, was used. muLISP-83 has been available since the summer of 1983. The reviewer evidently was in touch with The LISP Company in order to obtain its LISP when it was not generally available in the marketplace. It would have been a simple matter to call The Soft Warehouse, and, if not, to call Integral Quality to ascertain that all was cool. Your credibility is nil.

Gary M. Rader
Boulder, CO

All three LISP implementations were obtained from the respective distributors just before the review was written. Microsoft was the distributor from which muLISP was obtained. All parties were informed that the software was being reviewed for a magazine article and I would assume that they would want their latest and greatest software presented for the review.

I was in direct contact with Microsoft, Integral Quality, and The LISP Company while the article was written and received updates from Integral Quality and The LISP Company during this time, at their expense. If a new version of muLISP was available, it was not forthcoming from Microsoft at that time. I would expect to receive the same package from any of these sources had I placed an order with them.

All software reviewed is available, although each product is in a different stage of growth. The 16-bit version of the TLC-LISP is very new, and IQ LISP has been available for just over a year. On the other hand, muLISP has been out for a number of years. If significant enhancements have been made to muLISP, they should be presented; please do not discount the other two implementations because Integral Quality and The LISP Company delivered up-to-date versions of their software.

—William G. Wong

PC Packrats

I read your editorial ("Database Programs are Complex," February 1984, page 11) in the hope and expectation that you would describe the problem that drives the packrat in me up the wall: what do I do with my hundreds of "information-containing objects" (ICOs)—books, journals, articles from journals, correspondence, photographs, etc.—and their thousands of pieces of information so that I can find what I am looking for, quickly and easily, every time I want it.

The things I collect aren't a list; I don't want to produce columnar reports, with or without arithmetic capability. Neither do I want to write programs, not in high-level languages, not in so-called machine language. I just want to keep track of all that information, the ideas—my ideas—that are made explicit in my use of the information and that are, therefore, an evolving, substantially unstructured, slippery mass, only a minuscule fraction of which will ever exist in machine-readable form in any computer, let alone mine.

I am a "knowledge worker," to borrow Peter Drucker's term. There are millions like me, packrats to the tips of our toes, waiting to be helped to manage the information in which we are interested. We are all information managers, all our lives—lost without more information, overwhelmed with it.

As an "information junkie," I hope I've pressed your "help" key.

Robert M. Gordon
Beverly Hills, CA

Doubling Resolution

Here is a feature of the IBM PC display that, although not particularly useful, is interesting. I don't remember seeing it mentioned in your magazine.

Try this BASIC program:

10 INPUT X
20 OUT &H3B4,8 (These addresses are for the monochrome display.)
30 OUT &H3B5,X

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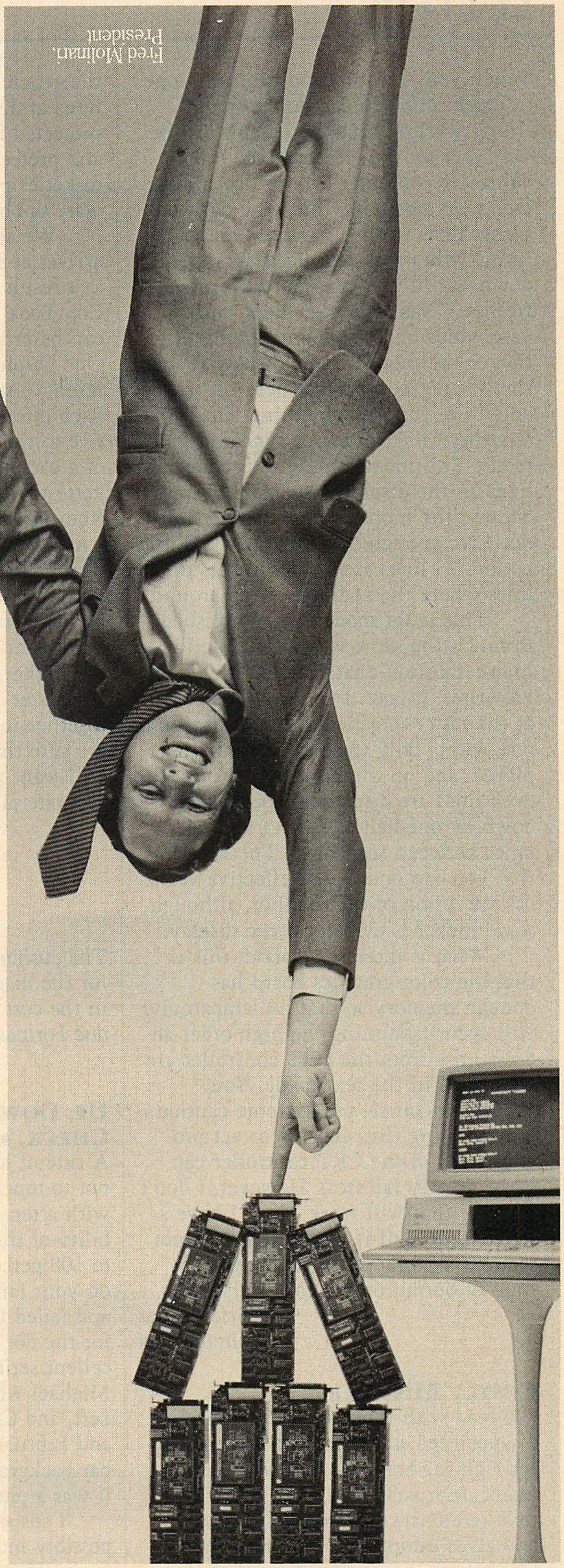
1195	General Purpose	DT2801	12	16SE or 8DI	13.7	12		16		
1345	High Speed	DT2801-A	↓	↓	27.5			33		
2170	High Resolution	DT2801/5716	16	8DI	2.5			16		
1295	Low Level	DT2805	12		13.7					
2270	Low Level, High Resolution	DT2805/5716	16	↓	2.5			↓		
1695	Simultaneous S/H	DT2818	12	4	27.5	↓	↓	33	↓	↓

NOTES: 1. PCLAB software supports all models. 2. Programmable gain is standard for all DT2801 and DT2805 models. 3. Screw terminal and signal conditioning panels available for connection of all I/O signals.



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When you run this, you can input one of three numbers. If you enter a 0, things work normally, and this can be used to reset the effects of the other values. If you enter a 1, you get *interlace sync mode*, in which the dark horizontal lines in the characters are filled in by "vibrating" the characters up and down slightly on consecutive screen refreshes. (This is most evident on inverse-video characters, but the resolution of the monochrome display is such that it's not very visible here.) If you enter a 3, you get something fairly interesting called *interlace sync and video mode*. This mode is used to produce 50 lines on the display instead of 25, but because the monochrome display does not have enough memory on board, the bottom 25 lines are a copy of the top 25 lines where the addresses wrap around.

This latter mode is accomplished in much the same way I generate these high-resolution characters on a C. Itoh Prowriter: it takes two separate sweeps of the raster to generate the display; on one sweep, only the odd lines are displayed, and on the next sweep, only the even lines are displayed, but shifted down by one-half of the normal distance between scan lines. The result is that you can double the effective vertical resolution of the monitor, although some flicker is evident in the display.

What is interesting about this is that the color graphics board has enough memory so that no wraparound will occur (assuming the high-order address lines from the CRT controller are connected in the text mode. You should, of course, use extreme caution when testing this since incorrect programming of the CRT controller can cause display failures). However, I don't know if that will work, since I have a monochrome. If it works, it would not seem at all difficult to get 50 distinct lines of output on a color display.

J. Eric Roskos
Nashville, TN

Costly Mistake

We read with interest, and with some disappointed surprise, "New Weapons for Fighting Software Piracy" (Werner Frank, February 1984, page 71). The article references our product, CopyLock, and gives information on price and technology that is significantly in error.

Formaster is the leading producer of piracy protection technology. CopyLock not only is the most effective system created so far, but it also is remarkably cheaper than anything else on the market. The cost of CopyLock is only 7 to 15 cents per diskette—not $7.50 as the article says. For pennies a copy, millions of diskettes per month have been protected by using Formaster equipment and protection technology including diskettes produced by the top ten software publishers.

We are concerned that your article arrives at some misleading conclusions as a result of the cost error. Formaster's CopyLock and Vault's Prolok (which can be produced on Formaster's Series One Duplicator) are both solid, but different, piracy protection technologies. Each offers a price/performance alternative to the user. Both allow production of a back-up or archive copy of the diskette while still providing protection from pirates. Formaster's CopyLock uses a magnetic protection signature; Vault uses a physical mark on the diskette. Although the magnetic signature may be inadvertently erased, the physical mark cannot, a factor that may balance the higher cost of Vault's protection. Formaster and Vault work very closely together in piracy protection, and we are sure that both of these companies will want your readers to be given an accurate picture.

Bill Senske
Vice-president
Formaster Corporation
San Jose, CA

The author accepts full responsibility for the inadvertent error that was made in the cost of CopyLock. Apologies are due Formaster.

—Werner Frank

Up, Down, Right, Left, Check, and Recheck

A rule of long standing for me has been not to touch a typeset program listing with a ten-foot pole because the probability of there being errors is very close to 100 percent. However, I slipped up on your January and February issues and failed to use a reading glass to look for the dot matrix in the otherwise excellent series by Dan Illowsky and Michael Abrash ("Up, Down, Right, Left, and Check," January 1984, page 46 and February 1984, page 93). The green bar background led me to believe that it was a photocopy of an actual listing.

I suspect at least one error, and possibly more, and would appreciate your comments on both the BASIC and the assembly language listings.

S.S. Starr
Rose Valley, PA

We won't say there aren't errors, but all PC Tech Journal *listings are, indeed, copies of printer output. Listings are printed on a Diablo 630 with a 15-pitch Gothic wheel and checked by editorial staff for reproduction errors. To assure accuracy, we will settle for nothing less.*

—WF

Frustration Prevention

A problem of great dimension has surfaced in the computer industry—one that is a cause of concern for thousands of computer users. I speak of the problem of user frustration.

An individual who purchases a computer from his local dealer sometimes gets sold a "bill of goods." Even if his dealer has been completely honest and aboveboard, the average user faces the problem of wading through a veritable Mt. Everest of manuals and other documents in an attempt to put his new purchase to work for him. A great percentage of such persons experience teeth-grating frustration.

What to do? I am attempting to organize a movement called the Society for the Prevention of Cruelty to Prospective Computer Purchasers (SPC→PCP). The purpose of the society would be to to link people with problems to people with solutions.

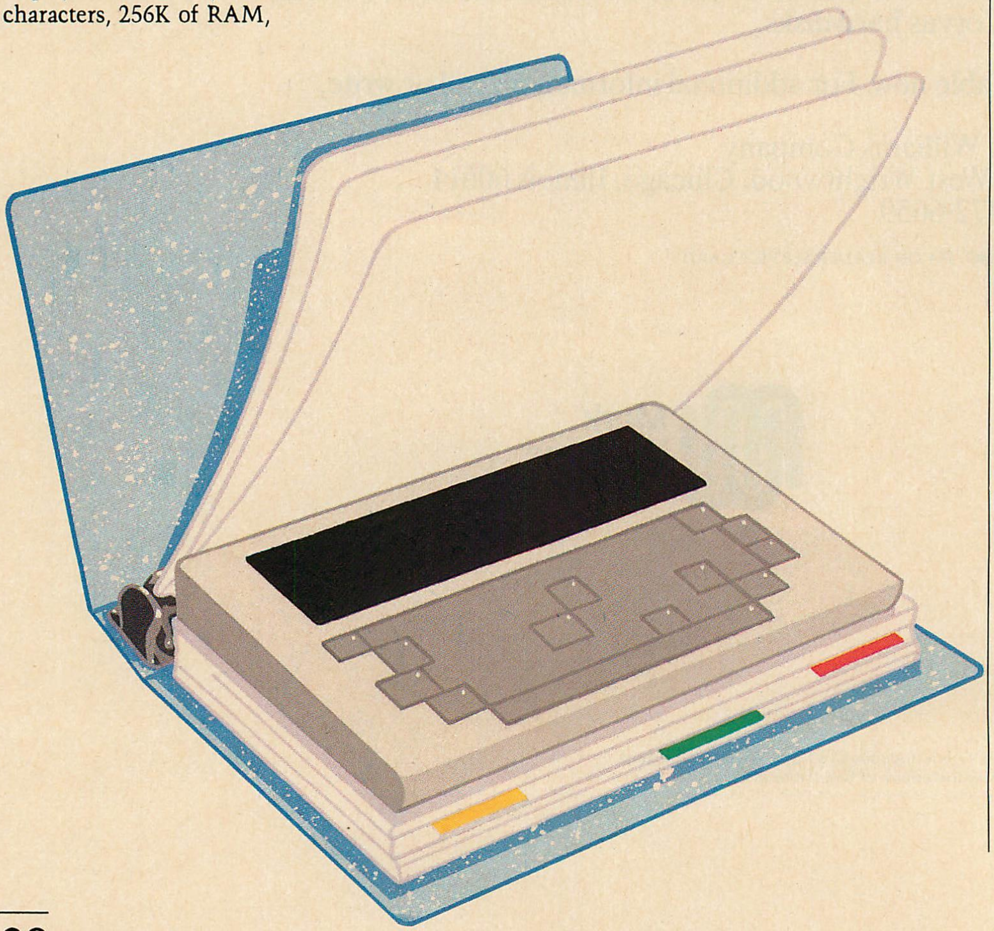
I have found through 20 years of experience in the computer industry that technical people are friendly, on the whole, and willing to help others. I am trying to find a large number of such technical people who would be happy to share their expertise with neophytes. Once I have accumulated such a list of experienced helpers, I shall advertise in computer magazines that such a list exists, and for a small fee (to cover the cost of the ads), anyone may send for a list of members in his area.

The response I have been getting is overwhelmingly enthusiastic. The technical community is more than willing to support such an endeavor. In the process, of course, they may make relationships with some very important contacts. Everyone benefits.

Burton Bhavisyat
Moundsville, WV

Random Rumors and Gossip

The latest report is that **Microsoft** does not expect to begin shipping its Windows extension for MS-DOS until late August, at the earliest. Microsoft originally promised to release the product in April. The company also promised that it would begin shipping its Window Toolkit to software developers in late May so that they could begin developing software that utilized the Windows extension. **Hewlett Packard** has reportedly shown prototypes of a new 9-pound portable system that has Lotus 1-2-3 and word processing in ROM. The unit will have a flat-screen display of 16 lines by 80 characters, 256K of RAM, and a price of $4,000. Similar units are also being offered by Hitachi and Mitsui, of Japan, as OEM products. Expect the units to go on sale this fall. **Tandon Corporation** is rumored getting set to release a new 5¼-inch floppy disk drive that could store 6 Mbytes and be expandable to 12 Mbytes. **IBM** is said to be working with Matsushita of Japan on the development of a notebook-size computer using a CMOS version of the 8088 and a three-inch disk drive. **IBM** also is rumored to be doing product evaluation testing of a laser-disk drive of less than 8 inches. The read-only drive should be able to store between .5 and 1 gigabyte. 3M is supposed to be the media supplier. **SCI Systems Inc.** of Huntsville, Alabama, which has been making the mother boards for the IBM PC/XT, Corona, Hyperion, and other clones, is reportedly getting ready to market its own PC clone. It is expected to use an 80188 processor, be multi-user, and use the UNIX operating system from Interactive Systems of Santa Monica, California (supplier of IBM's PC/IX operating systems). Word is that deliveries of **IBM XT/370**, originally expected in the early spring, have been pushed back to late summer because of delivery problems with the custom 68000 microprocessor and 8087 coprocessor chips used in the machine. **Commodore** is expected shortly to introduce an IBM PC-compatible based on the Hyperion transportable machine.



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IBM Making 8088 Chips

IBM is now manufacturing its own 8088 chips for its line of personal computers. The company signed a licensing agreement with Intel that will allow it also to make the 80186 and 80286, upgraded versions of the 8086/8088. Presently, IBM is making only the 8088 and Intel 64K RAM chips (under a previous agreement).

Intel has been having problems meeting the huge demand for the 8088. Its entire production for the remainder of this year is committed, and the company is already taking orders for 1985. To help fill these orders Intel has also licensed Sanyo and Commodore to make the 8088. Advanced Micro Devices is also making the 80186, and Intel is negotiating similar agreements with Harris, Matra-Harris, Siemens, Philips, Signetics, Intersil, NEC, and Fujitsu.

PC*jr* Sales Prove Disappointing

IBM reported that by the end of February, only about a month after starting to ship customer units to dealers, the company had already caught up with demand for the IBM PC*jr*. Meanwhile, the demand for the PC and XT is still so strong that IBM cannot ship enough units and does not expect to catch up this year.

Many dealers are reporting that they have plenty of *jrs* in stock, and in some areas—particularly in New York City and southern California—some dealers are of-

THE TECH JOURNAL NEWSLINE

News, views, and gossip on the IBM and IBM-like marketplace

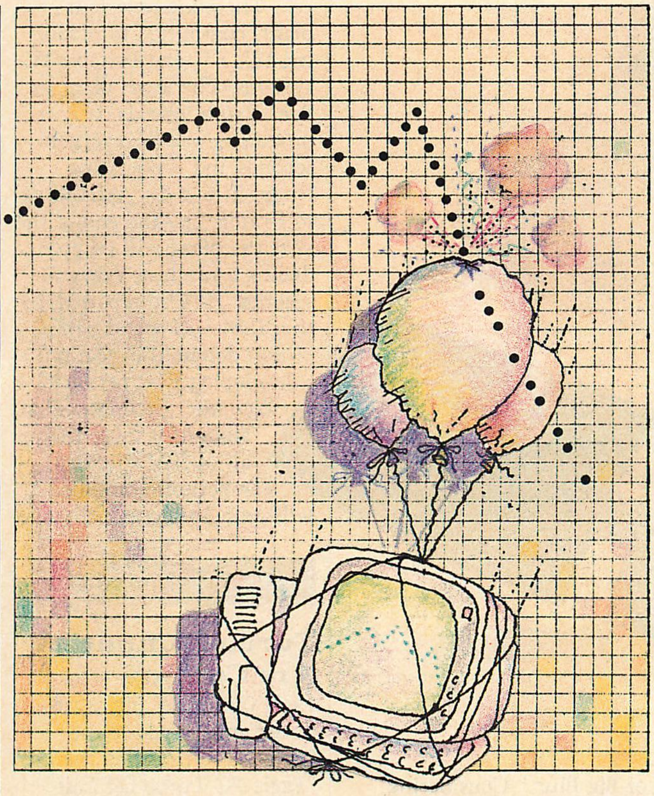


ILLUSTRATION • DAVID POVI LAITIS

fering substantial discounts on the *jr*. These discounts are ranging from $200 to $275 off the price of the enhanced version of the *jr*. American Business Products of Englewood, New Jersey, advertised recently that it would even throw in an enhanced *jr* with the purchase of an IBM PC or XT.

The resistance to the *jr* is based on several things. First, the machine is not very compatible with the PC/XT. Many PC/XT programs will not run on the *jr*, and few software suppliers have as yet brought out *jr* versions of software packages. Further, many business-oriented PC software packages will not run at all or will not run effectively in a machine with only one drive and 128K of RAM.

Second, the keyboard is very different from that on the PC/XT and does not lend itself to uses such as word processing. Third, the machine has a limited expansion capability. Finally, PC*jr* is an expensive home computer compared to machines such as Apple IIc (the new low-cost, portable version of the popular Apple II) Commodore 64, Radio Shack, and Atari systems.

Most dealers expect that as software becomes available and IBM and others introduce networking interfaces, the *jr* will be bought as a system that will enable people to take their work home from the office. Another factor expected to boost sales of the *jr* is IBM's promised expenditure of $40 million in saturation advertising for the machine. No other company can spend anywhere near that much to promote a single personal computer. There are also rumors that later this year IBM will introduce a better keyboard and will reduce the price for the *jr*.

However, even though PC*jr*'s sales have not skyrocketed in the manner of the PC and XT, IBM is selling a respectable number of units. Estimates are that between 40,000 and 50,000 units a month are being shipped. However, there were predictions that IBM would produce more than 1 million units this year.

MS-DOS V2.5 Reportedly being shipped to OEMs

Microsoft reportedly began shipping copies of version 2.5 of MS-DOS to Original Equipment Manufacturers (OEMs) in early April. There are also rumors that Microsoft is working on versions 3 and 4 of the operating system. Version 2.5, which is expected to be referred to as version 3 when it is released by OEMs, is believed to support multi-tasking and some networking, plus some other new features. It is expected that version 4 will be highly compatible with the Microsoft XENIX multi-user operating system. Version 4 is not expected to be released for sale until next year.

Microsoft is also known to be working on MS-Net, a networking extension of MS-DOS. This product is also not expected to be released until next year.

New PC Disk Drive?

There are increasing rumors that IBM will soon introduce a new 5¼-inch floppy disk drive option for the PC and XT, as well as for Displaywriter and Datamaster systems. The new drive will be able to store up to 1.6 Mbytes and is expected to become a standard for 5¼-inch floppy disks, since more than a half-dozen drive manufacturers are known to be planning to introduce half-height versions of these units shortly. An XT currently requires 28 floppy disks to back up the hard disk drive; the new drive will reduce that number to 6.

These units are expected to utilize dual speed motors and to read diskettes of either 48 or 96 tracks per inch. The drive motors can run at either 300 or 360 rpm. At the higher rate the drives would be compatible with 8-inch drive controllers that use the IBM disk format as a standard. (Currently there is no standard format for 5¼-inch drives.) These new drives could thus serve as easy replacements or addons for the 8-inch drives used in the Displaywriter and Datamaster. This would greatly enhance the portability of disk files between different IBM systems, which now is a problem.

Teac and Mitsubishi Electric already have these units in production; Shugart,

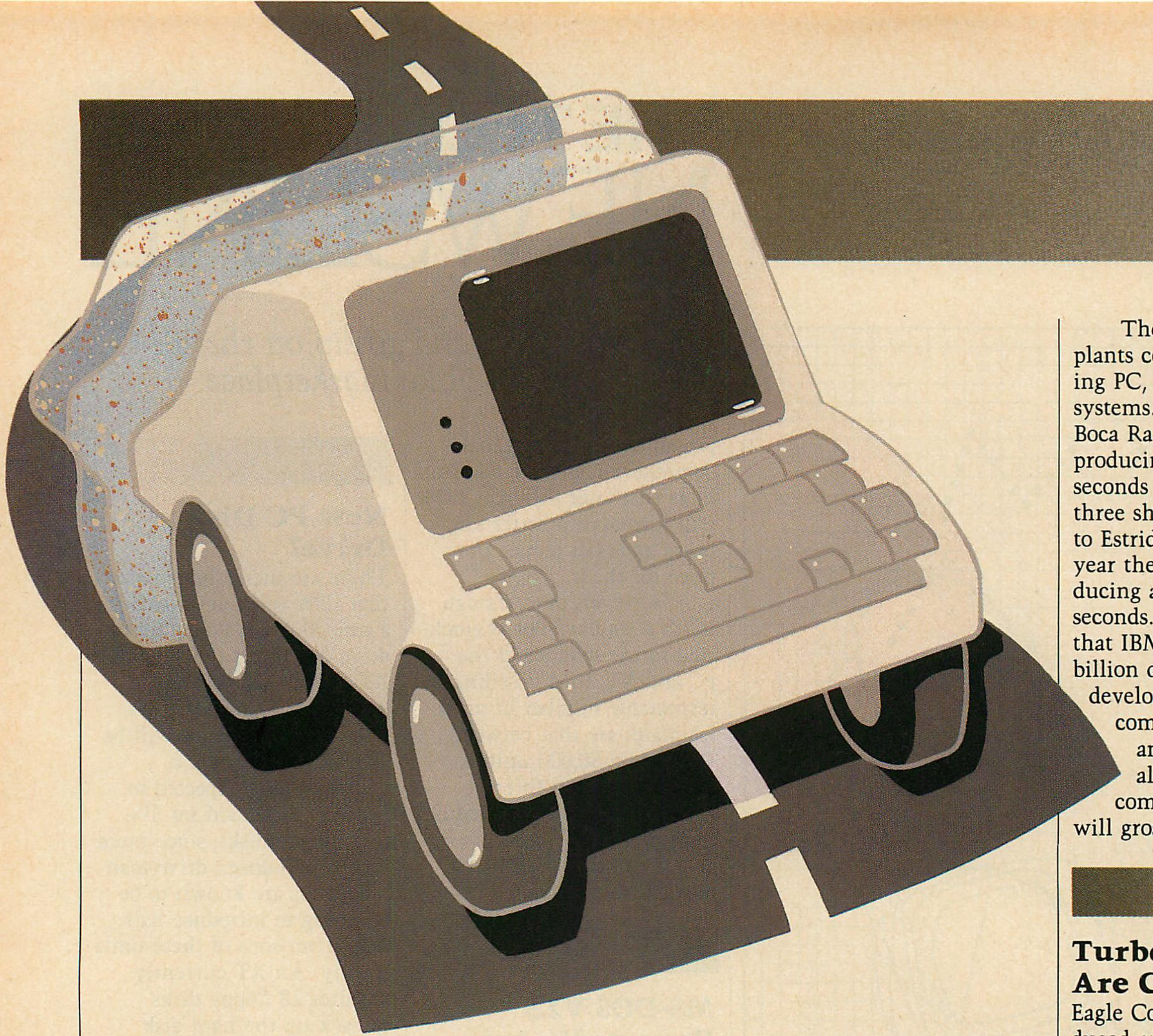


ILLUSTRATION • CAMERON WASSON

Qume, Matsushita, Tandon, YE Data, and Epson have also announced production plans for such drives. Pricing is already under $200 in quantities of 500 or more.

PC/XT UNIX Newsletter

Yates Ventures of Los Altos, California, a UNIX market research firm, publishes an excellent (but expensive—$450 per year) monthly newsletter for UNIX users titled "The Yates Perspective." The March issue carried two excellent articles on the IBM PC/IX UNIX implementation for the IBM XT. The authors conducted benchmarks on five different implementations of UNIX on the IBM XT (IBM's PC/IX, Venix, Microsoft/Xenix, Qnx, and Sritek/Xenix). I refer the reader to the specific articles, but generally speaking, the Sritek/Xenix, which uses a plug-in 68000 coprocessor board, was the fastest, and Microsoft/Xenix (which still has not been officially released for the XT) was the slowest. PC/IX is a single-user system, whereas all the rest are multi-user. Not surprisingly, the IBM implementation is the most expensive of the five.

Yates also predicts that IBM will add the Berkeley enhancements to PC/IX, and if UNIX Version V becomes popular, IBM will bring out a V Version for the XT. Yates further predicts that IBM will use Xenix as the operating system for its new 80286-based multi-user system and that "UNIX will emerge as the only operating system offered by IBM as a prelude to an AT&T buy-out of Big Blue." Considering that AT&T grosses about $34 billion annually and IBM grosses about $32 billion, I think Yates' last prediction is unlikely.

IBM Expanding PC Production

Don Estridge, president of the IBM Entry Systems division, which is responsible for the PC, has stated that IBM does not expect to catch up on the demand for the PC, XT, and Portable PC this year. The division expects to ship three times as many of these systems this year as it did last year, which means that more than 2 million of these systems should be shipped this year. A new IBM manufacturing plant in Wangaratta, Australia is also expected to start shipping products this summer.

There are now four plants committed to producing PC, XT, and Portable PC systems. The main plant in Boca Raton, Florida, is now producing one PC every 16 seconds and is operating three shifts a day. According to Estridge, by the end of the year the plant will be producing a machine every 7 seconds. He also reported that IBM will spend half a billion dollars this year on developing new personal computer products. That amount is more than all of IBM's leading competitors combined will gross this year.

Turbo Computers Are Coming

Eagle Computer Inc. introduced an upgrade to the Eagle PC to be called the "Eagle PC Turbo GT" (at first I thought it was a sports car). The 8086-based machine has a "Turbo" button on the front panel. Press it and the machine switches from the PC/XT compatible clock speed of 4.77 Mhz to 8 Mhz. High-speed RAM chips are used with no wait states, so that the machine runs at full speed with performance claimed to be two to three times faster than the standard IBM PC/XT.

IBM Expanding Retail Marketing for the PC

This year IBM is expected significantly to increase the number of dealers selling its personal computer systems.

The company is also expected to add 15 more IBM Product Centers, bringing the total to 75, with more promised by year's end.

IBM is also in the process of increasing the number of retail outlets and Value Added Resellers (VARs.)

There are about 1,400 retail outlets that carry the PC in the U.S. and another 800 internationally. In addition, there are about 300 VARs, which use IBM PC components in specialized custom systems. (For example, Nestar Systems of Palo Alto, California, is a VAR that uses PCs in a local area networking system.)

By the end of the year IBM should have about 3,000 outlets for its personal computer products. This is far greater than the number of outlets for competitors such as Apple and Tandy. Commodore, which currently sells almost exclusively to the home market, reportedly has about 10,000 outlets for its C64 and VIC systems; most of these are discount outlets.

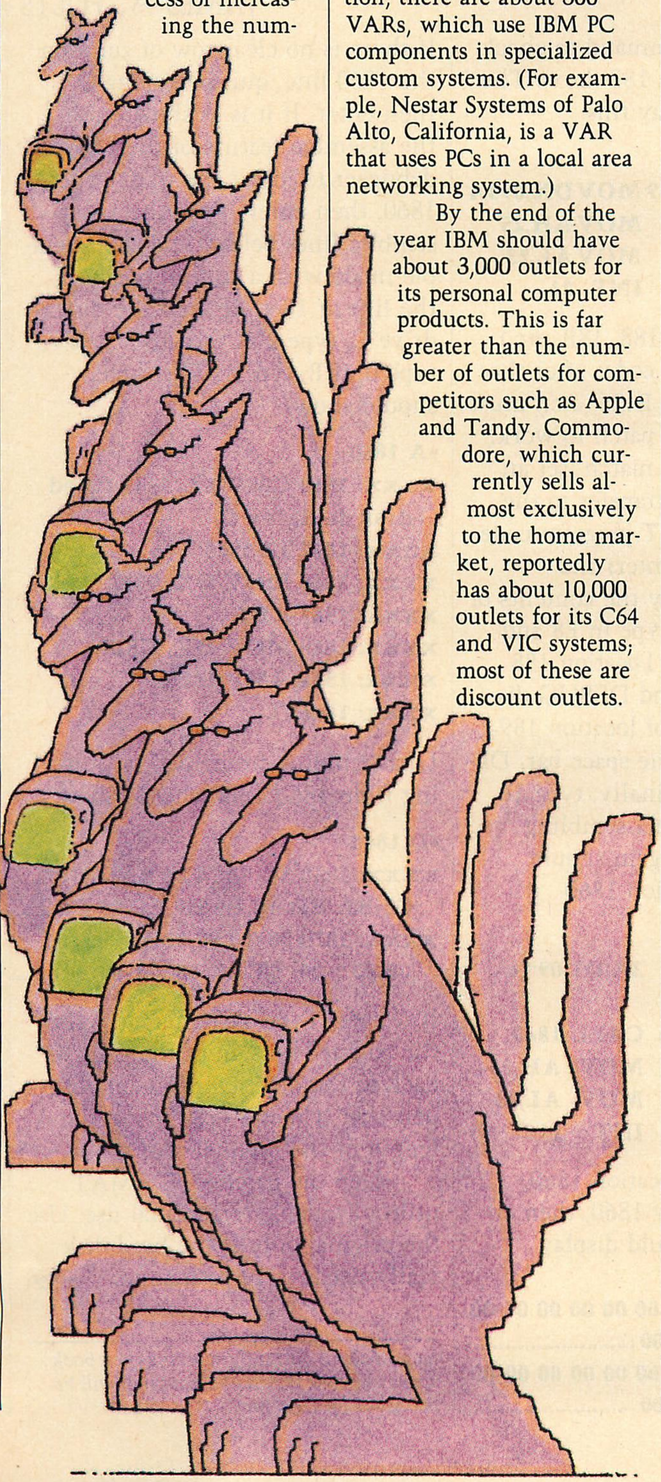


ILLUSTRATION • DAVID POVILAITIS

IBM Seeks Customs Protection

Following in the footsteps of Apple Computer, IBM has requested the U.S. Customs Service to check for imported counterfeit copies of more than 70 of its products. The products include primarily software packages and printed materials that violate IBM copyrights.

It is expected that IBM will also seek protection against the importing of PC and XT copies that violate copyrights of code contained in their system ROMs. Apple has previously tried to inhibit the importation of Apple II copies, with only moderate success.

COMPAQ Realigns Organization

Compaq Computer Corporation has announced that it is reorganizing into three separate divisions and a separate subsidiary. The new divisions will be: a portable computer division that will market the existing products; an office computer division that will market high-end products, the first of which should be a desktop unit based on the Intel 80186 or 80188; and an advanced computer division that will explore new display and storage technologies.

A separate Compaq Telecommunications Corporation has also been established; among its functions will be to explore integrated voice/data peripherals.

Compaq is also known to be planning to release a PC-compatible kneetop portable in the near future. The unit is expected to be imported from the Far East.

Random News Bits

Ten more **Sears Roebuck** computer centers will open this year, raising the company's total to 60. **Bill Gates,** president of Microsoft, developer of PC/MS-DOS, stated that by the end of 1983 Microsoft's operating system was running on more than one million personal computer systems. **VisiCorp** revealed that in 1983 it sold more than 230,000 copies of the VisiCalc spreadsheet program. **The IBM Federal Systems Division**, Bethesda, Maryland, has announced the development of a microcomputer chip, using NMOS technology, that can perform 100 million instructions per second (MIPS). By comparison, the 8088, used in the PC and XT, is rated at 0.5 MIPS. **IBM** has again increased its investment in Intel, from 18 percent to 20 percent. Under its agreement with Intel, it can purchase up to 30 percent of Intel's stock. Only 10 percent to go!

Quotation of the Month

In response to a question about a new version of the PC based on the 80286 microprocessor, Don Estridge, president of IBM Entry Systems Division, said, "It does not make sense to build a new product on parts you can't get . . . and I'm not trying to be flippant."

Disarming DOS FORMAT

TECH NOTEBOOK 20

A patch that keeps the hard disk from being accidentally erased

JAMES A. FOLTS

If you have a hard disk, keeping a copy of the DOS FORMAT utility accessible is like keeping a loaded gun on your coffee table.

Accidentally typing FORMAT instead of FORMAT A: when the default drive is C will erase the hard disk. The utility doesn't even ask if the user is sure; it immediately clobbers everything. The following patch traps calls to format the fixed drive, displaying an error message, "Invalid drive parameter."

How The Trap Works

Where the intercept call originates in the program (location 188), the AL register contains a number corresponding to the drive to be formatted. The trap checks to see if it is the fixed disk that is to be formatted. If not, it executes an instruction that has been overwritten at location 188, then resumes at location 18B. If AL does correspond to the fixed disk, the trap sets the DX register to point at an error message, then jumps to an error exit routine at location 53E.

Making the Patch

Begin by copying FORMAT.COM and DEBUG.COM onto a spare diskette to avoid damaging the DOS disk. Put the copy in drive A. Type DEBUG (enter). Now specify the file and instruct DEBUG to load it:

```
-N FORMAT.COM
-L
```

To make certain you have the version of the FORMAT utility for which this patch was designed, use the unassemble command to check the code at location 188 (hex). The screen should display this:

```
-U 188
xxxx:0188 BA3A09 MOV DX,093A
xxxx:018B B425   MOV AH,25
xxxx:018D B023   MOV AL,23
xxxx:018F CD21   INT 21
```

The offset address (188, 18B, etc.) and the instruction codes after the addresses (BA3A09, B425, etc.) must be identical for the patch to work.

If the numbers match, set an intercept at 188 to transfer to the end of the FORMAT program code. Then type E 188 (enter) and DEBUG will display the contents of location 188: BA. Type in E8 and press the space bar. Location 188 now contains E8, and DEBUG displays the contents of location 189: 3A. Type D5 and the space bar; DEBUG displays 09. Finally, type 16, then press enter. Unassembling from location 188 again should show a call to location 1860:

```
-E 188
xxxx:0188 BA:E8   3A:D5 09:16
-U 188
xxxx:0188 E8D516  CALL 1860
xxxx:018B B425    MOV  AH,25
xxxx:018D B023    MOV  AL,23
xxxx:018F CD21    INT  21
```

Now dump from location 1860. Type D followed by 1860, then enter. The screen should display

```
-D 1860
xxx: 1860 00 00 00 00 00 00 00 00-00
  00 00 00 00 00 00 00 ..........................
xxx: 1870 00 00 00 00 00 00 00 00-00
  00 00 00 00 00 00 00 ..........................
```

If there is no clear row of zeros on the 1860 line, quit by typing Q, then enter. If it is as shown, use the assemble feature of the DOS 2.0 debugger to insert the trap. Type A 1860, then enter. Type the six assembler lines below. End the assemble mode with a control-break. In the line at 1860, if the fixed disk is drive C, type 2 as shown; if it is A, type 0, if B, type 1. The screen should show:

```
-A 1860
xxxx: 1860 CMP AL, 2; if fixed
  disk is drive C
xxxx: 1862 JZ 1868
xxxx: 1864 MOV DX, 93A
xxxx: 1867 RET
xxxx: 1868 MOV DX, CED
xxxx: 186A JMP 53E
xxxx: 186E ^C
```

Unassembling from 1860 or dumping from 1860 again should show

```
-D 1860
xxxx: 1860 3C 02 74 04 BA 3A 09
  C3-BA ED 0C E9 D0 EC 00 00........
xxxx: 1870 00  00 00 00 0 0  00  00
  00-00  00  00  00  00  00 00 00........
```

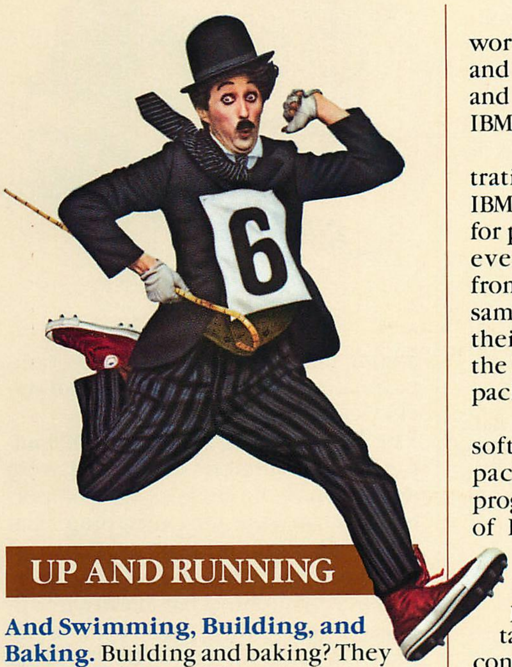
If it does, Type W (enter) to write the patched version of the utility back to the disk. DEBUG should report that it wrote 1780 bytes, the length of the original file.

Keep the patched FORMAT utility available for normal use. Use the original only if the hard disk really needs to be formatted.

James Folts is currently working on a book about the IBM PC and PCjr, which will be published by Datamost.

READ  ONLY

A review of the IBM Personal Computer family. Summer 1984



UP AND RUNNING

And Swimming, Building, and Baking. Building and baking? They don't produce gold medal winners, but they do figure in staging the Olympic games. So do 200 IBM Personal Computers (including software) that are part of IBM's sponsorship of the 1984 Olympics in Los Angeles. In fact, IBM PCs are hard at work in both sports and administration.

PCs are involved in a wide range of planning and analytical activities, though they don't provide official results of the various athletic events. Some events, for example, use the IBM PC to determine how competitors are seeded—who competes against whom. In other events, such as archery, the PC simplifies the complex task of recording scores and compiling statistics for each athlete as the competition progresses.

In events like gymnastics that depend on points awarded by judges, statistics can be kept on the PCs to analyze scoring consistency. Also, a whole range of information about individual athletes, past Olympics, and world and national records, both past and present, can be quickly recalled and compared with the help of the IBM PC.

Last but not least, administration. Spreadsheet programs, such as IBM's Multiplan™, were used on the PC for planning and forecasting by nearly every administrative department, from Construction to Ticketing. The same departments speed up some of their day-to-day accounting tasks with the help of the PC and IBM accounting packages.

Departments with specific software needs developed special packages with the assistance of a programmer whose services are part of IBM's Olympic sponsorship. Specially designed programs include database management applications to help handle transportation requirements and inventory control programs to keep track of sports equipment and personnel records.

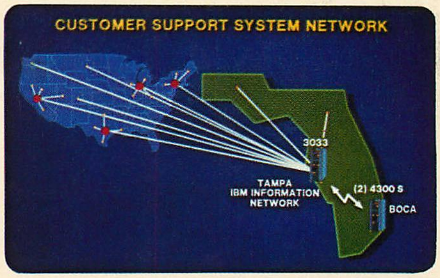
In short, there's hardly an area of planning and staging the 1984 Summer Olympics that the IBM Personal Computer doesn't play a part in. Maybe there *should* be medals for administration.

Multiplan is a U.S. trademark of Microsoft Corporation.

ON THE STOREFRONT

A Shorter Distance between PC Points. We're all familiar with the feeling of being lost in the growing maze of new computer products. IBM has opened a path through that maze, straight to the information and answers you need about IBM Personal Computer Products—information about a specific software package or hardware configuration and answers to technical questions.

The key to entering this new information path is the IBM Customer Support System (CSS) at your authorized IBM Personal Computer retail dealer or IBM Product Center. Dealers in over 300 cities throughout all 50 states use the Customer Support System, which includes a nationwide communications network, to help give you instantaneous computer-age service support that's unmatched by any other computer manufacturer.



Colorful Stops along the Way. More than 1,700 authorized IBM dealers have access to a permanent and continually updated directory of IBM Personal Computer product information in IBM's Customer Support System. For a sharp color display of the type and level of information you want, visit your dealer or IBM Product Center and choose from lists of options displayed on an IBM PC color monitor. There are choices that guide you quickly and easily from product directories to in-depth product demonstrations and configuration information.

Since knowing how to take the first step is often a problem, CSS gives you a variety of possible starting points. By selecting the appropriate category—such as printers or business software—you can move to a list of specific products and then to the

Information from CSS with simple one-key commands

product demonstration you want. If you know a product name to begin with—Word Proof, for example—CSS will make an alphabetic search for it. To keep you up-to-date, there's also a special listing for new product announcements.

You can browse through the CSS displays at your own pace, pausing at a given spot or moving quickly backward or forward by using simple one-key commands that are always displayed at the bottom of the screen. One of these commands enables you to make print-outs of any information you wish to save for future reference.

The IBM PC family's color graphics capabilities make the CSS software demonstrations especially impressive. The Multiplan demonstration, for example, consists of several consecutive screens of information. Each screen is split vertically, with representative sections of the actual program on the left and explanatory text on the right. By the time you've seen the entire demonstration, you'll have a good idea of both *what* the program can do for you and *how* it does it.

Answers at the End of the Line. Over 1,000 authorized IBM retail dealers and IBM Product Centers are linked through their Customer Support System to the IBM Information Network. This nationwide communications capability helps your dealer give you fast, efficient service. Warranty claims, for instance, can be handled through CSS with a minimum of paperwork and delay. Dealers also use the network to communicate with other dealers and with IBM to keep abreast of the latest product and service information.

In addition, the CSS network is your gateway to technical information about the IBM Personal Computer family of products. IBM maintains a database on a 3033 mainframe in Tampa, Florida, that your dealer can use to answer—within minutes—a wide range of questions. If the solution isn't on hand in the database, your question can be submitted through CSS to a technical support staff in Boca Raton. There, it will be analyzed and an answer returned through CSS to your dealer.

The information used to answer your inquiry is added to the CSS database, where it will be immediately available for anyone else with a similar question. Your technical inquiries therefore contribute to the growth of the Customer Support System. Its on-line product information, color graphics displays, and advanced communications all have a single purpose—to help you get the most out of your investment in IBM Personal Computer hardware and software products.

HARDWARE NEWS

Color. There's color news for the IBM PC, IBM PC XT, and IBM *Portable* PC in the form of the IBM Personal Computer Color Printer. It's a high-performance, dot matrix printer that can print charts, graphics, artwork, and text in up to eight colors. The Color Printer produces color graphics that can enhance the appearance of your reports and presentations and make the information they contain even easier to understand. It can also type directly onto overhead transparencies.

The IBM PC Color Printer's range of performance features make it especially well suited for heavy-use/high-productivity applications. A near letter quality printing mode is standard. Printing speeds of up to 200 characters per second can help save time. So can programmable automatic control of print requirements such as print mode, line spacing, and margin and tab setting. These programmable features act as an extension of many software products—word processing programs, for instance—and can be initiated with just a few keystrokes.

A final feature for those who like a personal touch. You can use the Color Printer to personalize your documents by varying the printing modes, character spacing, and boldness. This allows you to differentiate among headlines, subheads, and quotations and even to print math and science equations.

The IBM PC Color Printer

The Big Crunch. Not long ago, computing and number crunching were nearly synonymous. Personal computers and software for everything from office management to agriculture changed that, but the need for heavy number crunching has hardly disappeared. If it's still a part of your computer workload, the IBM Personal Computer 8087 Math Co-processor can help speed up your calculations.

The 8087 is a floating point co-processor that multiplies, divides, adds, subtracts, exponentiates, and performs trigonometric and logarithmic functions. It works together with the PC's 8088 processor to improve the execution speed of floating point operations by as much as 10:1. The Math Co-processor increases calculation speeds so greatly because it makes floating point operations a hardware rather than a software function.

In addition to increasing the speed—and often the level of precision—of statistical and analytical math packages, the Math Co-processor can improve the display speed of graphics and video games. It also significantly improves high-level language execution time, and is designed to work with the APL Interpreter and the version 2.0 Pascal and FORTRAN Compilers discussed next in this issue.

WHAT'S THE PROGRAM

We Speak Your Language. IBM Personal Computers are shameless polyglots. They can handle most of the popular programming languages you want to work with. Much of the credit for their versatility goes to the IBM Disk Operating System (DOS) 2.10. This updated version of DOS 2.00 was developed to provide support for the IBM PCjr as well as for the IBM PC, PC XT, and IBM *Portable* PC. So all members of the IBM Personal Computer family are united by a single master program that provides the required support between their hardware and a wide range of application programs.

More to our present linguistic point, the DOS 2.10 diskette contains two programs, Disk BASIC and Advanced BASIC, to help you write your own programs on an IBM PC. (IBM PCjr BASIC—a separate, optional cartridge—provides this support for the PCjr.) Disk BASIC adds DOS file support, date, time of day, and communications capabilities to the BASIC language that comes with every personal computer from IBM. Advanced BASIC adds advanced key trapping and advanced graphics—including viewports, windows, and paint tiling—plus music and other capabilities.

DOS has other features that help simplify advanced program development and design, including a line editor, a linker, background printing, and chaining of commands. For help with writing and editing particularly sophisticated BASIC programs, there's the BASIC Programming Development System, a software package that consists of two programs and four utilities. The first program includes a Text File Editor and a Structured BASIC Pre-processor; the second includes a BASIC Formatter and a BASIC Cross-Reference.

Native Translators Available. The IBM BASIC Compiler compiles or translates the BASIC programs you've written, down to native object code so they'll run on your IBM PC. And BASIC is just the beginning. DOS also provides the support you need to develop and run programs using the IBM Personal Computer Macro Assembler or the FORTRAN, COBOL, and Pascal Compilers.*

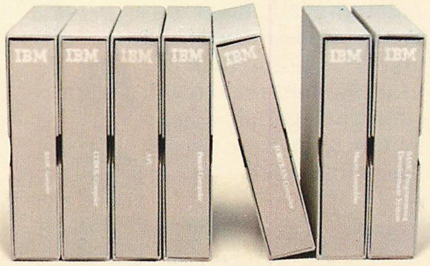
Two of these, the FORTRAN and Pascal Compilers, are available in recently updated versions. IBM PC Pascal 2.0 is based on the ISO standard, and IBM PC FORTRAN 2.0 conforms to the ANSI-77 standard subset level. Both new versions feature improved arithmetic capabilities, and both support the IBM 8087 Math Co-processor for greatly increased speed in processing floating point calculations. (For more about the Math Co-processor, see "Hardware News" in this issue of *Read Only*.)

In addition, versions 2.0 of the FORTRAN and Pascal Compilers feature a Library Manager for creating user-defined libraries and provide easy access to all files in any subdirectory through DOS path support. FORTRAN 2.0 supports linking of object modules with subroutines written in Pascal 2.0 and vice versa. Both new versions support linking of object modules with subroutines written in IBM PC Macro Assembler.

There's a bargain in store for those who already own the 1.0 versions of these compilers: you have the option of buying an upgrade to the 2.0 version at a substantial savings from the full 2.0 price.

To ensure that your programming reach doesn't exceed your grasp, the IBM PC APL Interpreter enables you to write and edit your own programs in APL. It can also be used to exchange data files and workspace between your IBM PC and many mainframe computers.*

Finally, if you're inclined to make serious use of the IBM PC's array of programming aids, we suggest that you also take a look at the recently announced IBM PC Sort program. It provides support for data types and file organizations used by the IBM DOS-supported languages mentioned above and can significantly speed and streamline your programming efforts.

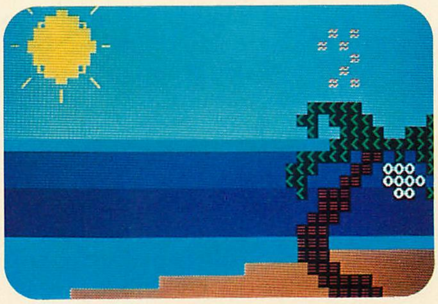


Application development tools from IBM

IBM PC Sort can be used as a stand-alone utility, integrated into a batch job stream, or invoked directly from a COBOL program via the Sort verb. It can sort records from a data file or files, merge multiple input files, selectively include or exclude records, and create an output file containing the records, pointers, or keys from the input files. There are no arbitrary limits in IBM PC Sort for file size, record length, number of keys, or number of input files.

*BASIC Compiler and Macro Assembler will run on the IBM PCjr. APL Interpreter will not. Although the IBM PCjr does not support FORTRAN, COBOL, and Pascal Compilers, most of their output will run on the PCjr if there is sufficient storage.

Now Get Organized. The IBM PC's ability to run a wide variety of commercially available programs and to help you develop your own applications may result in a good news/bad news situation. The good news is that you'll be able to satisfy your application requirements. The bad news is that you'll probably be the one responsible for keeping track of your growing library of programs. If, as we've often found, enthusiasm outstrips organization, you may find yourself falling behind—especially if you're working in an area, such as small business finance or education, where programs multiply rapidly.



Animation Creation software from IBM

Fortunately, help is in sight, in the form of Fixed Disk Organizer, an IBM software package that does just what its name suggests.

Fixed Disk Organizer has a master menu that lets you sort out your various application programs by category—word processing, spreadsheet, communications, and so on. You can tailor the menu to your specific application needs by adding new menu categories, revising or deleting existing categories, or changing titles. The master menu allows you to review all the programs stored on your fixed disk at a glance and to call them up quickly with just a couple of keystrokes.

Fixed Disk Organizer also helps protect sensitive data by allowing you to create passwords and restrict access. It also enables you to write a

string of complex DOS commands into a batch file and execute them whenever you want simply by selecting that file from the menu. And in case part of your organizational problems stem from not always remembering just how things are organized, you can use Fixed Disk Organizer to establish Help files as a reminder.

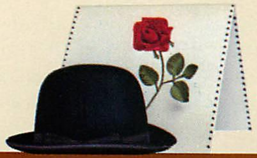
So we're all in trouble—no more excuses for not being organized.

Moving Pictures and Mathematical Castles. Let's not forget that there's more to life than programming, compiling, and getting organized. There's also software from IBM for pure enjoyment and for enjoyable education. Two such packages are Animation Creation and Adventures in Math.

Adventures in Math incorporates math drills into an adventure game with vivid color graphics of a castle and its passageways and treasures. To find the way out—and to uncover as many treasures as possible along the way—children (or particularly skillful adults) have to solve basic math problems. The program's difficulty level increases as you solve the problems you're confronted with.

Using Animation Creation, you or your children can draw your own pictures and watch them come to life. To draw pictures, you select from 254 computer characters and position them on your screen. Add color by choosing any of 16 foreground and 8 background colors. Then, by slightly repositioning the images on successive screens, you can create animation.

Next stop, Hollywood.

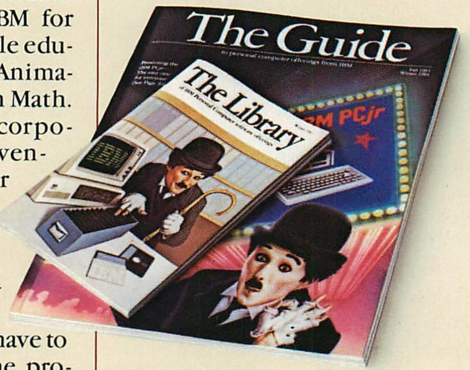


HARDCOPY

You Can't Enjoy the Game without a Program. Earlier in this issue (see "On the Storefront"), we discussed the Customer Support System for online information about IBM Personal Computer products. Much of that information is also available in two publications: *The Guide,* a directory of Personal Computer offerings from IBM, and *The Library,* a directory of IBM Personal Computer software offerings. If you want to enjoy the personal computer game, these are the "programs" you need to do it.

The Guide, published twice a year, is a catalog that contains clear, concise descriptions of IBM PC, IBM PC XT, IBM PCjr, and IBM *Portable* PC systems. It also reviews printers, video displays, expansion units, and all other IBM PC hardware products. A separate section of *The Guide* contains articles on IBM PC software packages.

Both hardware and software articles are illustrated



with annotated color photographs—of key screens for the software packages—and start with charts that provide quick product overviews. Other noteworthy features include sample configuration tables for all three systems and a closing section on Sales and Service Support.

The Library, updated quarterly, presents an overview in booklet form of the entire IBM PC software product line. It presents the software by category, with sections on Operating Systems and Languages, Personal Productivity, Communications, Business, Education, and Entertainment. Program descriptions are brief and to the point. Each includes a short overview, program highlights, and system requirements. There's also a chart at the end of the booklet that shows at a glance which programs are compatible with the IBM PCjr.

Or the Hardware without a Manual. If *The Guide* and *The Library* are the general road maps to IBM PC products, the *Technical Reference* and *Hardware Maintenance and Service* manuals*—now available in newly updated versions—are the detailed maps of downtown. It's not a trip everyone wants to take, but if you do, these are the right directions.

There's a three-volume *Technical Reference* set for the PC and another for the PC XT and *Portable* PC. These manuals include the functional specifications for the system units and for the options and adaptors in the IBM PC product line. The *Hardware Maintenance and Service* manual details many aspects of troubleshooting a personal computer from IBM. It includes a parts catalog, a section on preventive maintenance, and instructions for identifying the failure of a replacement unit.

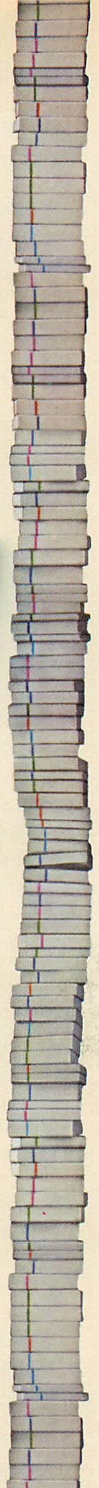
*These manuals are intended for use by technically qualified service personnel.

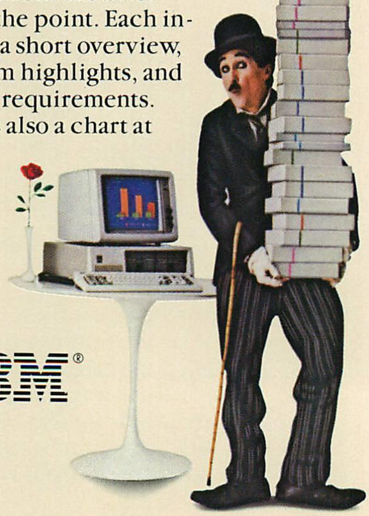
TIPS AND TECHNIQUES

If you use Personal Editor—IBM's full-screen editor for writing programs and brief documents—but find yourself displaying the Help file whenever you forget a function key assignment, here's a little help from the fellow forgetful.

Function key assignments can easily be displayed on the command line of your Personal Editor screen by assigning Fl to display the unmodified keys and alt+Fl to display the alt+Fx keys. You can then assign the Help function to alt+H, although you probably won't need it nearly as often as before.

The macro for the Fl assignment can be written as follows: def fl = [cursor command] [begin line] 'F: 2=Save 3=File 4=Quit 5=Erase 6=EraseEOL 7=Print 8=Switch 9=InsL 10=Ins&Indt' [cursor data].





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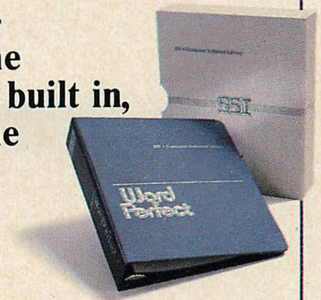

*Based on tests performed on an IBM PC.

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Mathematical Modeling with TUTSIM

A useful but expensive simulation tool for engineers and scientists

WILLIAM H. MURRAY

TUTSIM is an interactive program that simulates the dynamics of systems. It gives the user the ability to create mathematical models of circuits, machinery, and systems and then to vary the parameters of the model for maximum efficiency or for optimum design. To run the IBM version of TUTSIM, an IBM PC with 64K of memory, a color-graphics adapter, and an optional IBM/Epson Bit Graphics printer are needed. The single diskette and manual are available from Applied i for $525.

TUTSIM was developed at Twente University of Technology (TUT) as a simulation (SIM) tool for scientists and engineers. It was originally designed to run on a PDP 11 computer, but has been redesigned to run on Apple, IBM and CP/M-based computers.

TUTSIM accepts model information in the form of mathematical equations via block diagrams or bondgraphs. These mathematical models, or systems, can then be "run" and analyzed graphically.

William Murray is on the computer science faculty at Broome Community College in Binghamton, New York.

The user can tune the model by changing internal and external parameters and then "run" the model again. Models can take the form of electromechanical systems, fluid dynamics, static and dynamic mechanical problems, continuous batch chemical processes, geophysical modeling, econometrics, thermodynamics processes, physiological and biological models, and electronic devices and circuits. The complexity of the model is left to the imagination of the user as long as it can be created with the "building blocks" shown in table 1.

TUTSIM allows models to be entered through the keyboard or retrieved from a diskette file. Entering a new model involves four main steps: entering the model structure, entering the model parameters, entering the output blocks and ranges for analysis, and entering the timing data for graphical display. In order to illustrate the use of TUTSIM, I will enter a hypothetical model and analyze the results.

A Block Diagram Model

Most people have had to replace shock absorbers on a car at least once. The process involves deciding what type of replacement shock should be used—would regular, heavy duty, or extra heavy duty replacements be best?

Because a suspension system for a car can be described as a vibrating spring with damper, a second-order differential equation can be written to describe its operation. This equation will form the basis of my TUTSIM model. A standard shock absorber uses a 1-inch piston and fluid, much as the closer on a screen door does (although some door closers work with air). Heavy duty shock absorbers often change the piston diameter to 1 3/16 inches to increase damping, and it is even possible to purchase extra heavy duty shocks with 1 3/8-inch pistons. One manufacturer claims that its heavy duty shocks provide a 40-percent better ride, while their best shocks provide 90 percent more control than standard shocks. A dynamic model can be used to investigate these claims.

The first job is to write the second-order differential equation for a vibrating spring with damper. Fortunately, this equation can be found in most calculus-oriented freshman physics books:

$$M\, d^2x/dt^2 + R\, dx/dt + (1/C)\, x = F$$

where M equals the mass attached to the spring (wheel assembly), R equals the resistance to vibration (shock absorber effect), C equals the spring constant, and F equals the force required to depress the spring.

The next job is to produce a block diagram of the mathematical model. Figure 1 shows an appropriate block diagram with the TUTSIM symbols entered in each block. I would strongly recommend that the user construct models on scratch paper before attempting to enter the data on the keyboard.

Each block performs a function as described in table 1. For this particular model, the PLS (pulse) block represents the depression force for the assembly. This could be a stone in the road or a curb that the driver happens to drive over. The SUM block is needed because the equation has been rearranged to fit a "control model" form that provides feedback from both integrators. Actually, the form for the model can be represented by this equation:

$$F - R\, dx/dt - (1/C)\, x = M - d^2x/dt^2$$

The attenuator block for M and C and the gain block for R are means for entering these constants into the model. Because gain is treated as the reciprocal of attenuation, either form can be chosen as long as the parameters are entered correctly.

Once the block diagram has been completed on scratch paper, each block should be numbered sequentially. The model can then be entered into the TUTSIM program.

Entering Model Structure. Once TUTSIM is booted, the user

> *Once the block diagram has been completed on scratch paper, each block should be numbered sequentially. The model can then be entered into the TUTSIM program.*

will be given the options of performing keyboard input (K), performing model file input (F), or continuing with the present model (N). For this example, I selected the keyboard option (K). Note that all TUTSIM responses must be in upper-case, an indication that this program was adapted from an earlier Apple version.

Once (K) is typed, TUTSIM responds with the prompt:

```
MODEL STRUCTURES
FORMAT: BLOKNBR,
  TYPE, INPUT1,
  INPUT2 . . .
```

The user then responds:

```
1, PLS
2, SUM, 1, -6, -7
3, ATT, 2
4, INT, 3
5, INT, 4
6, GAI, 4
7, ATT, 5
```

Note that each entry starts with the block number, followed by a TUTSIM description of that block's function and a list of any blocks that form inputs to the block being described. When the model is completely entered, press return.

Entering Model Parameters. TUTSIM will automatically prompt for the model's parameters

Turn
the page.

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do a number
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Table 1: TUTSIM Model Blocks

ABS -	absolute value of an algebraic sum	**LME -**	¦
FIX -	integer value of an algebraic sum	**LIM -**	limit function (max and min)
AND -	returns a one if the inputs are all true	**MAX -**	maximum value
ORR -	returns a one if any of the inputs are true	**MIN -**	minimum value
ADL -	output is delayed one defined time step	**MUL -**	arithmetic multiplication
CON -	permits a constant to be entered	**DIV -**	arithmetic division
COS -	cosine of angle in radians	**SUM -**	arithmetic summation
SIN -	sine of angle in radians	**NOI -**	pseudorandom noise generator
DEL -	a delay given in units of simulation time	**FIO -**	solution to a single pole complex system element
EXP -	e raised to a power	**PID -**	time solution to the transfer function
LOG -	base e log	**PLS -**	pulse function block
FNC -	function generator	**PWR -**	raise inputs to a power
FND -	function duplicator	**SRT -**	square root of inputs
GAI -	gain block (multiplier)	**REL -**	relay function block
ATT -	attenuation block (divider)	**RSQ -**	square of resistance inputs
INT -	¦	**GSQ -**	square root of conductance inputs
EUL -	¦ Integrator blocks	**SPL -**	sample and hold function
LMI -	¦	**TIM -**	access to present simulation time

Table 2: TUTSIM Commands

CS	Change the structure of the model	**HC**	Print a hard copy of the graphical screen
CP	Change the parameters of the model	**DF**	Save a model file on disk
CB	Change the plotblocks and ranges		
CT	Change the timing parameters	**L**	List the model file
		LP	List the model file on the printer
SD	Start simulation, results to display		
SN	Start simulation with numerical results	**MG**	Display in graphic mode
SNP	Start simulation with numerical results to printer		
SP	Start simulation with print-plot output	**TT**	Type timing data
SPP	Start simulation with print-plot to printer	**TTP**	Print timing data
		TB	Type output blocks and ranges
PD	Proceed with results to display	**TBP**	Print output blocks and ranges
PN	Proceed with numerical outputs	**TS**	Type a structure line
PNP	Proceed with numerical output to printer	**TSP**	Print a structure line
PP	Proceed with print-plot output		
PPP	Proceed with print-plot output to printer	**A**	Abort the TUTSIM program (Back to IBM system)
		HP	Help on the available commands
V	Verify last calculated value	**I**	Replace initial conditions by outputs
VP	Verify last calculated value on printer	**A**	Restart the TUTSIM program
		(space bar)	Interrupt model simulation
GD	Draw a grid		
CL	Clear the graphical screen		

when the user exits the model structure phase:

MODEL PARAMETERS
FORMAT:
BLOCKNBR,PARAMETER1,
PARAMETER2, . . .

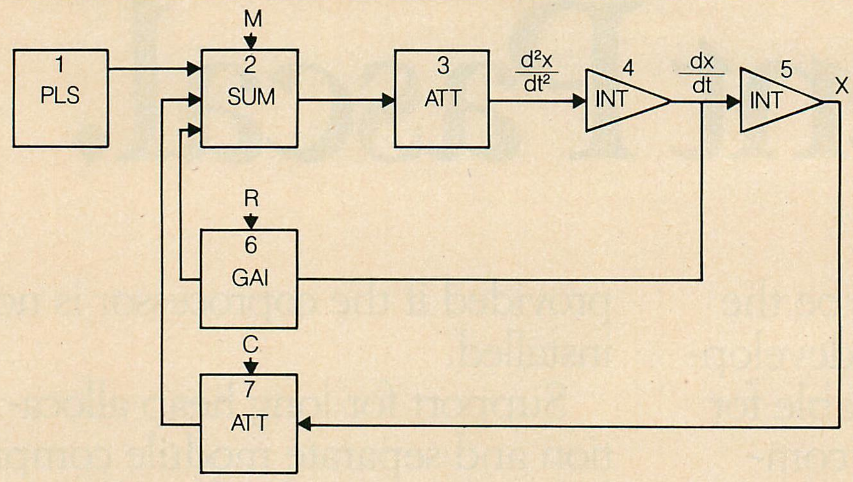
Respond by describing the physical attributes that should be affixed to the model:

1, 10, 20, 1
3, 62.5
6, 3
7, 1

Again, a carriage return will exit the user from the parameter-entry phase of TUTSIM. In this model, only blocks 1, 3, 6, and 7 allow for external parameters. By using the reference portion of the manual, the user can determine how blocks are to be specified. Block 1 is a PLS block representing the depression of the spring. In the parameter list the block number appears first, followed by two times (the start of the pulse and the end of the pulse). The time units are relative to the analysis time. Finally, the pulse height is specified in relative units. For this example, a unit pulse height was chosen.

Block 3 allows the mass of the system to be entered. In this case, the mass is determined by dividing the weight by the acceleration due to gravity. The damper coefficient for Block 6 was selected to be 3.0 and the spring constant for Block 7 was selected to be 1.0. Every number chosen for this model was selected in harmony with the others

Figure 1: A Block Diagram Model of a Shock Absorber System Ready for Entry in TUTSIM Program.



in order to produce the desired graphical results. When a graphical analysis is performed for each of the "shock absorbers" under test, it will be Block 6's parameter that will be changed. (Note: the current value for a standard duty shock was chosen to be 3. A heavy duty shock should be 40 percent greater, or 4.2, and an extra heavy duty shock should be 90 percent greater, or 5.7.)

Entering Plotblocks and Ranges. TUTSIM will now prompt with

PLOTBLOCKS AND RANGES
FORMAT: BLOCKNBR,
PLOT-MINIMUM,
PLOT-MAXIMUM

Respond with

X1:0, 0, 200
Y1:1, −1, 9
Y2:5, −1, 1

Block 0 in the specification (X1:0,0,200) is used to specify the *X*-axis. The second 0 indicates the starting time for the analysis, and the 200 indicates the ending time. Again, the times are relative to the other specified parameters. The Y1 specification indicates that the output will be viewed from Block 1 (the pulse block), plotted vertically using a scale of −1 to 9 units. Y2 will be the plot from Block 5 (the dynamic displacement of the wheel assembly), plotted vertically using a scale of −1 to 1. A carriage return after the last specification exits the user from the plotblock phase.

Entering Timing Information. TUTSIM requests timing information for the simulation with the following prompt:

TIMING DATA
FORMAT: DELTA, FINAL TIME

For this model, enter these values:

:0.1, 200

Delta specifies the step-size. The smaller the value of Delta, the more calculations are made per unit of time. *Final time* refers to the length of time the simulation should last. The user's manual suggests a ratio between these two values of about 1:100. Actually, the ratio is not critical, and a poor selection will do nothing more than slow down the graphical output.

After these values are entered, TUTSIM will return the user to the command mode. The TUTSIM model is ready for analysis.

Model No. 1 (Simulation). In order to view the model graphically, I chose to draw a grid and then start simulation. The following commands were all that were necessary to obtain photo 1, the plot of a standard shock absorber:

:GD
:SD

A summary of commands can be obtained from the user's manual or by typing (H), for help. Table 2 is a listing of these commands.

Changing Parameters in Model No. 1. The parameters for a particular model can be changed by typing

:CP

For the heavy duty shock absorber I would type

6, 4.2

This would indicate to TUTSIM that Block 6 has a new value of 4.2. For the extra heavy duty shock, 6,5.7 would be entered. Photo 2 shows the graphical representation for the heavy duty shock; photo 3 illustrates the extra heavy duty shock. Do you see a significant difference between the two shocks?

Table 3 gives commands that will permit changes in the model, model simulation, interrupts in model simulation, etc. It is from this "Command Level" that models can be saved and displayed. Outputs can be specified for display on the screen, or data can be typed on the printer. Table 3 shows a portion of a printer output for the standard shock absorber system.

A Bondgraph Model

TUTSIM offers the additional feature of allowing models to be entered with bondgraphs. The bondgraph technique is defined by the TUTSIM program as "inspection of components rather than production of equations." Anyone who thinks this is going to be an easy route around those differential equations should forget it; it is sometimes hard to work with bondgraphs.

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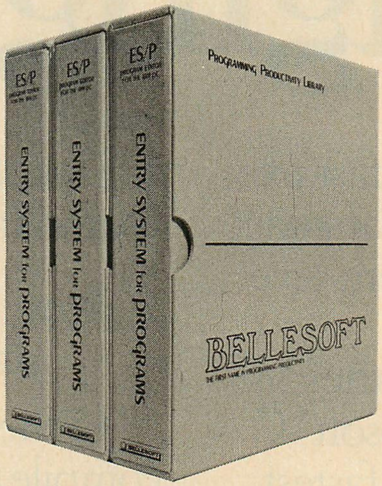

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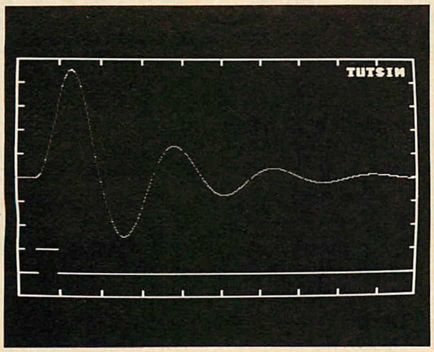

Photo 1:
A TUTSIM plot of a second-order differential equation. This model simulates a standard shock absorber system.

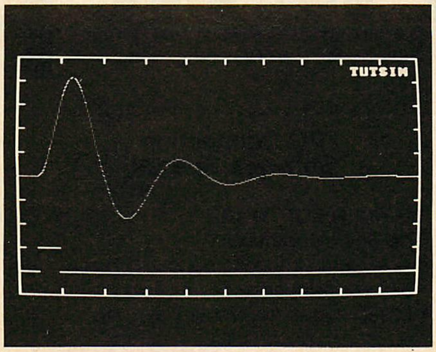

Photo 2:
A TUTSIM plot of a heavy duty shock absorber-spring system that gives a 40-percent increase in damping over a standard shock absorber.

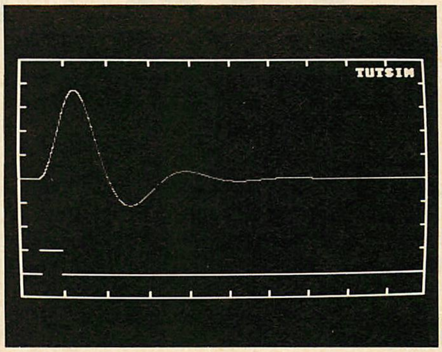

Photo 3:
A TUTSIM plot of an extra heavy duty shock absorber system, which gives a 90-percent increase in damping over a standard shock absorber.

To exemplify the use of bondgraphs, another second-order differential equation can be used to define an R-L-C electrical circuit and then to analyze how that circuit responds to a pulse response.

The first step is to draw the circuit. Figure 2 shows the placement of a capacitor, resistor, inductor, and pulse generator. The components are numbered sequentially, a current direction is chosen, and the correct voltage drop polarities are specified across the passive components. The bondgraph information can now be entered.

To illustrate the ability to change bondgraph models, I have chosen three cases to observe with an R-L-C model: overdamping, underdamping, and critical damping.

Entering Model Structure. The bondgraph model is specified in much the same way as the block model is. In response to the prompt

MODEL STRUCTURE
FORMAT: BLOCKNBR,
TYPE, INPUT1, INPUT2, ...

the following information should be entered:

1, C, 2
2, L, 4, −1, −3
3, R, 2
4, PLS

Initially, it looks exactly like the block diagram model. In the bondgraph model, the first number stands for the component number, the letter or letters are the appropriate bondgraph symbols from the bondgraph table at the end of the user's manual, and the remaining numbers refer to components that connect to or affect that particular component. Because the model being created is that of a series R-L-C circuit, the Kirchhoff loop equations are in terms of a current driver. Thus, for the resistor and capacitor these equations are true:

$i = v/R$
$i = C * dv/dt$

The inductor's *i*, however, is specified in terms of an integral. Rather than use this specification, I chose to specify the *i* in terms of its voltage parameter:

$v = L * di/dt$

Thus, when Block 2 is specified, the "4" represents the voltage source that will drive the component. This example may seem difficult to understand, but compared to some of the examples in the TUTSIM manual, it is quite clear.

Remaining Bondgraph Parameters. The rest of the model is specified just as a block structure model is. To illustrate changing bondgraph models, I have chosen three cases to observe with an R-L-C model: overdamping, underdamping, and critical damping. These cases refer to how quickly the oscillating system will damp out (dissipate its energy, as heat, through the resistor). Photo 4 illustrates the overdamped case with a capacitor value of 1.25 farads.
Photo 5 shows the critically damped case with a capacitor value of .25 farads and photo 6 shows the underdamped case with a capacitor value of .01 farads. Parameters for the overdamped case are then entered:

MODEL PARAMETERS
FORMAT: BLOCKNBR,
PARAMETER1,
PARAMETER2, . . .

The parameters that I entered were

1, 1.25
2, 1
3, 4
4, 1, 10, 1

These parameters mean that the capacitor (component 1) has a value of 1.25 farads, the inductor (component 2) has a value of 1 henry, the resistor (component 3) has a value of 4 ohms, and the pulse generator (component 4) produces a pulse 1

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Table 3: Optional printer output of "standard shock absorber" data points. The step size was changed to limit the listing to 50 lines.

```
PLOTBLOCKS AND RANGES
FORMAT: BLOCKNBR,PLOT-MINIMUM,PLOT-MAXIMUM
     0  0.00000E+00   0.20000E+03
     1 -0.10000E+01   0.90000E+01
     5 -0.10000E+01   0.10000E+01

  0.00000E+00   0.00000E+00   0.00000E+00
  0.50000E+01   0.00000E+00   0.00000E+00
  0.10000E+02   0.00000E+00   0.00000E+00
  0.15000E+02   0.10000E+01   0.00000E+00
  0.20000E+02   0.00000E+00   0.00000E+00
  0.25000E+02   0.00000E+00   0.90000E+00
  0.30000E+02   0.00000E+00   0.87600E+00
  0.35000E+02   0.00000E+00   0.25864E+00
  0.40000E+02   0.00000E+00  -0.38775E+00
  0.45000E+02   0.00000E+00  -0.67270E+00
  0.50000E+02   0.00000E+00  -0.51607E+00
  0.55000E+02   0.00000E+00  -0.10311E+00
  0.60000E+02   0.00000E+00   0.27960E+00
  0.65000E+02   0.00000E+00   0.42452E+00
  0.70000E+02   0.00000E+00   0.30129E+00
  0.75000E+02   0.00000E+00   0.35821E-01
  0.80000E+02   0.00000E+00  -0.19328E+00
  0.85000E+02   0.00000E+00  -0.26567E+00
  0.90000E+02   0.00000E+00  -0.17419E+00
  0.95000E+02   0.00000E+00  -0.47629E-02
  0.10000E+03   0.00000E+00   0.13134E+00
  0.10500E+03   0.00000E+00   0.16511E+00
  0.11000E+03   0.00000E+00   0.99421E-01
  0.11500E+03   0.00000E+00  -0.78934E-02
  0.12000E+03   0.00000E+00  -0.88002E-01
  0.12500E+03   0.00000E+00  -0.10190E+00
  0.13000E+03   0.00000E+00  -0.55891E-01
  0.13500E+03   0.00000E+00   0.11591E-01
  0.14000E+03   0.00000E+00   0.58261E-01
  0.14500E+03   0.00000E+00   0.62451E-01
  0.15000E+03   0.00000E+00   0.30842E-01
  0.15500E+03   0.00000E+00  -0.11293E-01
  0.16000E+03   0.00000E+00  -0.38166E-01
  0.16500E+03   0.00000E+00  -0.37997E-01
  0.17000E+03   0.00000E+00  -0.16624E-01
  0.17500E+03   0.00000E+00   0.95018E-02
  0.18000E+03   0.00000E+00   0.24767E-01
  0.18500E+03   0.00000E+00   0.22946E-01
  0.19000E+03   0.00000E+00   0.86850E-02
  0.19500E+03   0.00000E+00  -0.74017E-02
  0.20000E+03   0.00000E+00  -0.15934E-01
```

time unit after the start of the plot. The pulse has an amplitude of 1 unit and lasts for 10 time units.

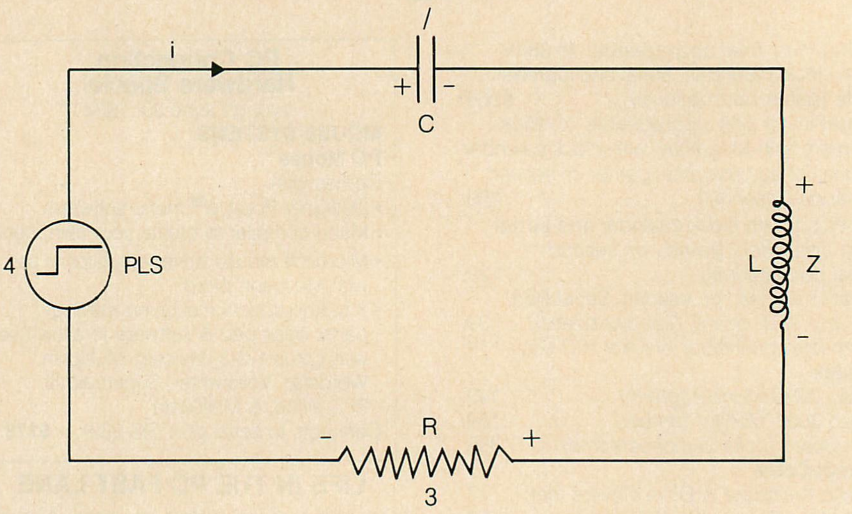
After the message

PLOTBLOCKS AND RANGES
FORMAT: BLOCKNBR,
PLOT-MINIMUM,
PLOT-MAXIMUM

I entered

X1: 0, 0, 10
Y1: 3, −2, 2
Y2: 4, −1, 5

Figure 2: A Second-Order R-L-C Circuit in Bondgraph Form for Entry as a TUTSIM Model.



Block 0 indicates that the *X*-axis will plot time from 0 to 10 time units. Block 3 will be a plot of the voltage developed across the resistor. Block 4 plots the PLS generator.

Finally, to the message

TIMING DATA
FORMAT:DELTA, FINAL TIME

I responded

0.1, 10

This sets increment size to .1 and simulation time to 10 units.

Opinions, Recommendations, and Conclusions

This product does some pretty fancy things. With a small number of commands, the user can enter very complex mathematical models and simulate them dynamically, something I dreamed of doing when I took my first physics course. Models can be created and "fine-tuned," as the shock absorber example was, to fit the designer's needs. TUTSIM should therefore be a popular program in R & D development work.

TUTSIM is not for beginners. First, the program works with fairly high-level mathematics. Even people comfortable with first- and second-order differential equations will be challenged by bondgraphs. The bondgraph and block diagram models contained in this review are simple examples designed to illustrate the various features of TUTSIM. The complexity of the whole process of model creation increases rapidly. To help understand this product, users would be wise to consider taking a course or reading a book on modern control systems. I would recommend *Modern Control Systems* by Richard C. Dorf, published in 1974 by Addison-Wesley.

I was disappointed with the documentation and software in a number of ways. For $525, I would have expected a more polished product. The manual is a short collection of mimeographed pages placed in a nondivided three-ring binder. It abounds with spelling and typographical errors. The holes in the pages were punched too far from the edge, so that it is somewhat difficult to turn the pages.

It is obvious that the manual and the software are quickly reworked Apple products: one quote that escaped the proofreader was "back to Apple basic." I don't like being forced to enter commands with capital letters and I don't like expensive software that doesn't take advantage of the special function keys that my system provides.

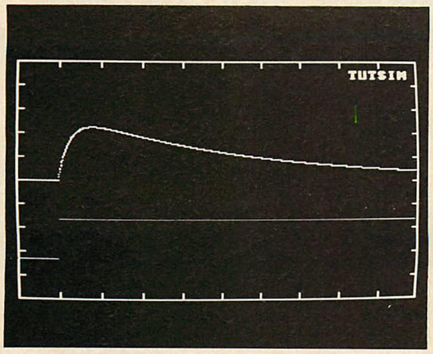


Photo 4:
A TUTSIM model of a second-order differential equation for a R-L-C circuit. The capacitor value is selected for an underdamped case.

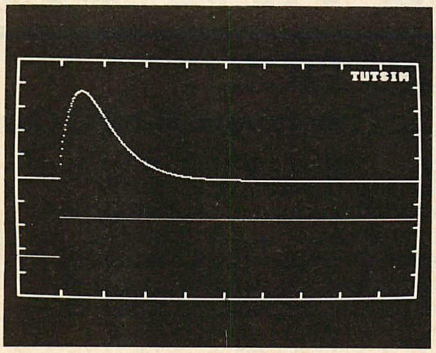


Photo 5:
Photo 4's R-L-C circuit with the value of C altered to give critical damping.

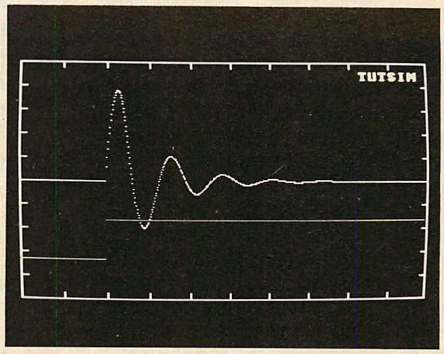


Photo 6:
Photo 4's R-L-C circuit with the value of C altered to give underdamped results.

Notice that the word TUTSIM appears in the upper right corner of every plot. It's there to stay, because only the executable code is provided with the disk. TUTSIM is the only label the user can have on a graph. No provision was made for axis numbers or labels, which seems ridiculous for a product that costs as much as TUTSIM does. My final gripe about the graphs is that they can't be saved on diskette. Users who do not have an IBM printer that takes advantage of the Ctrl-PrtSc to dump graphics will not be able to obtain a plot of the graphics.

Overall, TUTSIM is a good product. It would be a great one if it had a better manual, improved graphics, and a lower price.

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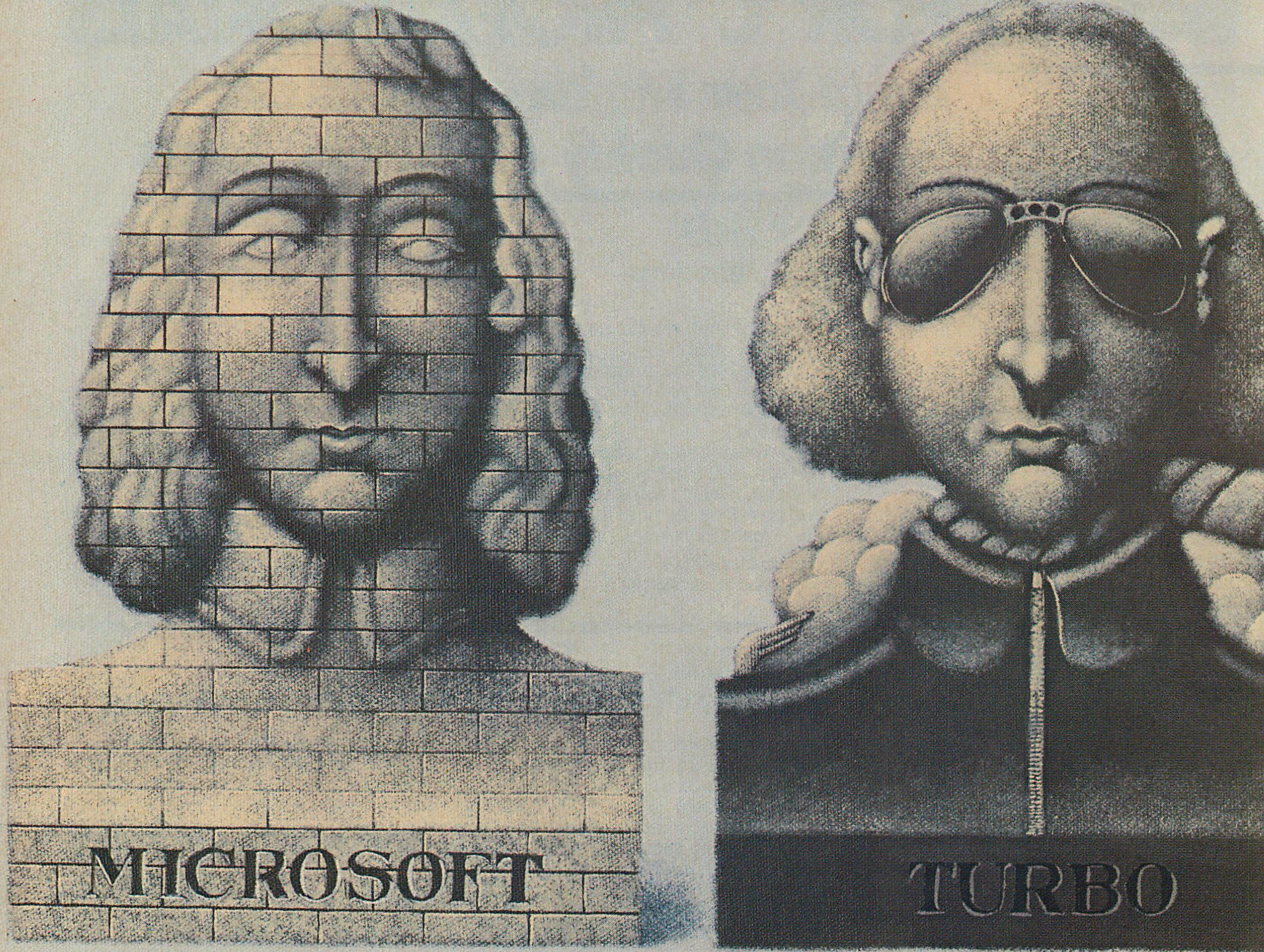


Pascal Ti

The major Pascal compilers on the market today—MS Pascal, Pascal MT+86, SBB Pascal, and Turbo Pascal—are put through their paces

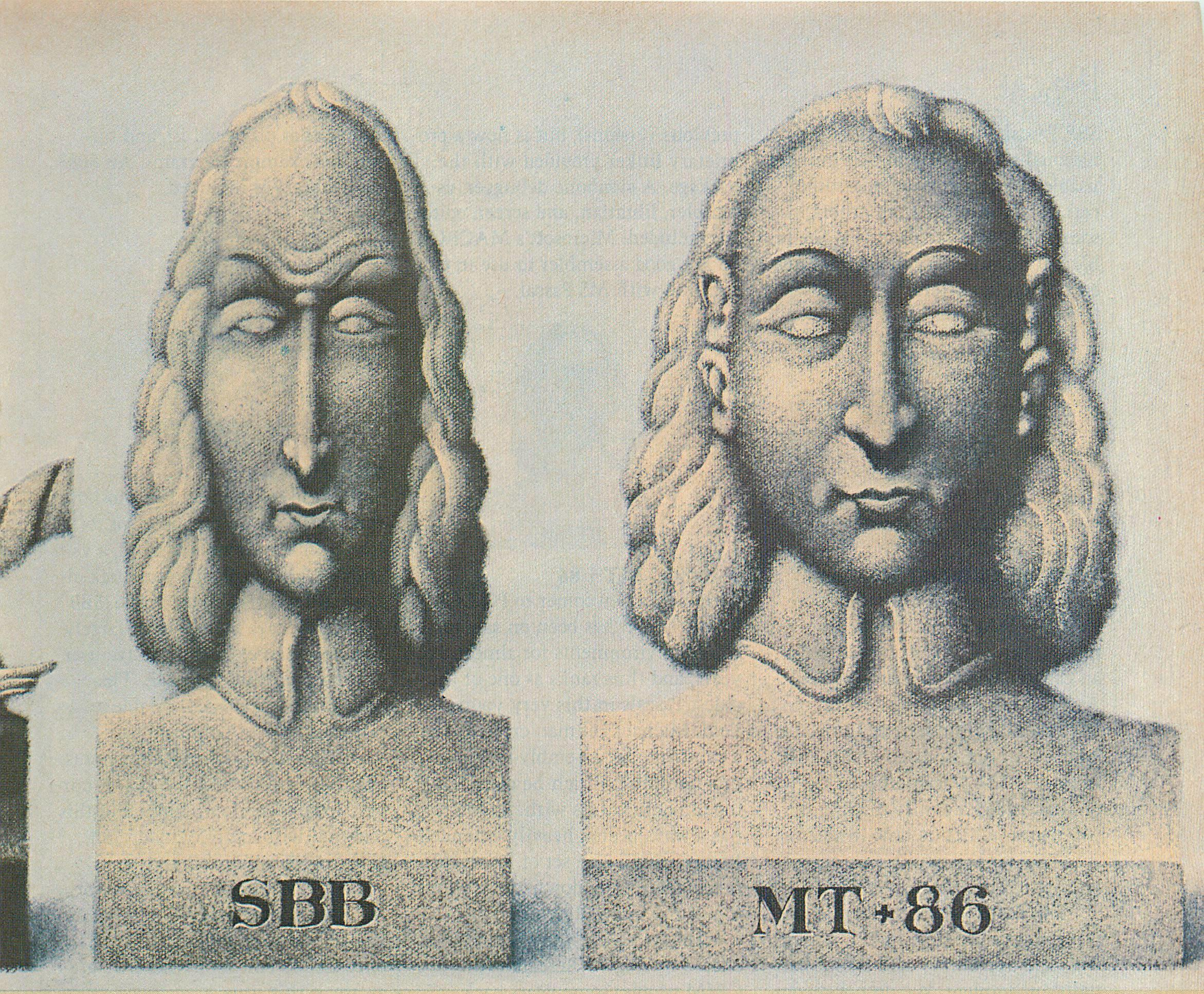
JEFF DUNTEMANN AND MICHAEL BENTLEY

"Pascal? Gimme a break!" sighed the young UNIX hack. "Pascal's just a kiddie language, with both hands tied behind its back and one leg cut off. Now C, there's a language that a person can really get some *work* done with . . ."

This is heard regularly from young UNIX hacks. It comes from reading too many books about Pascal and never actually *using* it.

THE STANDARD THAT SANK A LANGUAGE

All those books describe ISO Standard Pascal, the only Pascal standard currently in print. And ISO Standard Pascal is indeed a kiddie lan-



mes Four

guage. It has no reasonable I/O, no low-level system hooks, none of the gritty necessities required to get work done in the real world. Its creator intended the language to be that way. Swiss computer scientist Niklaus Wirth invented Pascal to wean computer students away from virulent diseases like FORTRAN and COBOL and teach them how to write readable code. Pascal was meant to teach—and nothing more. It served as a finger in the dike while Wirth completed the design of Modula 2, a language that will be both standardized and useful.

While the mainframe world held to the "ISO Standard for Quadriplegic Pascal," microcomputer manufacturers gave Pascal back its limbs by extending the ISO Standard. The result is a nonstandard and nonportable language that can do anything C can do.

Only four Pascal compilers of any consequence are available for PC DOS right now: IBM/Microsoft Pascal, Digital Research's Pascal/MT+86, Software Building Blocks'

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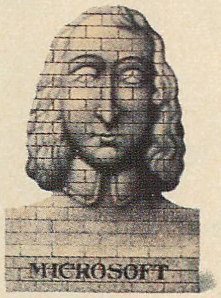
ILLUSTRATIONS • TIM CURRY

SBB Pascal, and Borland International's Turbo Pascal. All four are usable; none is perfect, and some certainly cost more than others, sometimes by a factor of ten. See table 1 for a summary of the features each compiler offers.



IBM/MICROSOFT PASCAL
IBM PC Pascal was available soon after the IBM PC itself was announced in late 1981. It is actually an early version of Microsoft Pascal. As far as we know, the version of MS Pascal sold under the IBM label has never been updated and is still in release 1.0. Microsoft sells the product independently of IBM as MS Pascal, which is now in release 3.2. This is the compiler we tested, not the IBM-packaged version.

MS Pascal is a considerable improvement over IBM Pascal, which was (and apparently still is) substantially incomplete. We do not recommend buying MS Pascal under the IBM label.

MS Pascal does not seem to have any migration paths to other CPUs or operating systems. It will, however, operate on virtually all MS DOS capable machines, including those that are light years from IBM PC compatibility, such as the Victor 9000 and the Zenith Z100.

MS Pascal lists for $350 and is packaged in one of Microsoft's transparent plastic flip-top boxes. The box literally broke in our hands while we were trying to remove the two very large, very fat user guides.

The software package includes the compiler and linkable libraries, including support for the 8087. The required linker is no longer the standard MS DOS LINK.EXE (as in previous versions), but is now a proprietary linker provided with the package. A symbolic debugger, assembler, librarian, and screen editor are included. Microsoft's MACRO-86 is a good assembler to use in conjunction with MS Pascal.

PASCAL/MT+86
Although a newcomer to PC DOS, Pascal/MT+ has been on sale for CP/M environments for almost five years, and thus ranks as one of the oldest Pascals in this very young field. Michael Lehman created it as a substitute for assembly-language programming, which he considered too difficult to fuss with. So MT+ has always been a heavily extended Pascal, with a rich set of low-level hooks for getting down and wallowing in the bits and bytes.

Lehman's company was purchased by Digital Research (the CP/M people) some years back. MT+ is now available for CP/M-80, CP/M-86, PC/MS DOS, and CP/M-68K. We should mention that we have used this compiler for several years (on CP/M-80) and have more experience on it than on the borrowed compilers, which we had for five or six weeks at most.

Pascal/MT+86 lists for $400 and comes in a grey-brown slipcase binder matching the rest of the Digital Research product line. The release we tested is V3.2. The package includes the compiler, a proprietary linker (Microsoft's LINK will not link MT+86's output code), an 8086 assembler, a librarian for knitting routines together into libraries, a symbolic debugger, a Pascal disassembler (which associates generated assembler source with the Pascal source that produced it), and numerous example programs. An 8087 reals library is included.

SBB PASCAL
SBB Pascal, written by Jeff Moskow, is actually the 16-bit successor to Ithaca Intersystems' Pascal/Z, a venerable 8-bit Pascal that goes back almost as far as Pascal/MT+86. SBB Pascal's lineage is important largely because of an extremely active user group supporting Pascal/Z. This user group has made available a large number of public-domain disks containing Pascal/Z programs, routines, and technical hints. A cursory look suggests that much of this material will compile under SBB Pascal without any tinkering.

SBB Pascal also is available for the Ithaca Intersystems' proprietary Z8000 operating system. It is the only Z8000 Pascal of which we are aware at this time.

So when Borland introduced Turbo Pascal late last year for $49.95, we were rather skeptical. How good can a Pascal be for 50 bucks?

Like Pascal/MT+86, SBB Pascal comes in a large slipcase binder. The suggested list price is $350. We tested release 2.0, which includes in

its package the compiler, linkable libraries including 8087 support, a symbolic debugger, and a simple screen editor. An assembler is not included, and the compiler's output code is linkable by Microsoft's LINK.EXE. However, much of the source code (two single-sided disks worth) for the run-time support is included at no extra cost.

Turbo Pascal

People in the IBM PC community may or may not recall JRT Pascal, a peculiar P-code implementation that took the CP/M-80 world by storm a couple of years ago by appearing for $29.95 complete. It wasn't an especially good compiler, and the company has since gone bankrupt. So when Borland introduced Turbo Pascal late last year for $49.95, we were rather skeptical. How good can a Pascal be for 50 bucks? After reviewing it, however, we have to admit: we are very impressed.

Turbo Pascal comes on a single diskette in an unprinted cardboard box. The manual is a bound paperback book, not loose-leaf, and is completely typeset. Whether or not it was intentional, it is hard to photocopy the manual without cracking the binding, especially since the manual is 250 pages long. At $50, Turbo Pascal is definitely too much bother to steal—Borland is attacking the piracy problem in exactly the right way.

This compiler includes a screen editor program that emulates the simpler commands from WordStar. If the compiler finds an error, you hit the Escape key and, bang, you're in the editor, with the cursor sitting square on the compiler's best guess as to what the problem is. The most amazing (and puzzling) feature of this editor is not what it does, but where it's hiding: the combined editor/compiler code file is only 33K long. Sure, all of that must be compiler . . . but no, that's just Turbo—tiny, and as we shall see, faster than greased lightning.

Turbo has no linkable libraries, because it does not support modular compilation as do the other three compilers. The only remaining files on the Turbo disk are a couple of example programs, including a simple spreadsheet program given in full source form.

Evaluation Criteria

What makes a good Pascal compiler? We decided upon ten criteria by which to judge the four compilers. In no particular order, these are:

1) Documentation. This is where user meets compiler, and first impressions can be important. How complete is the manual? Is it correct? Is it indexed? How well organized? Can you find anything in a hurry? Is it written for the Compleat Idiot or the Black-belt Hacker? Are there examples? Are they worthwhile?

2) Ease of use. How much energy, concentration, and elbow grease is required actually to get down and compile a program? How much disk swapping? Can it work with a hard disk? A RAM disk? Are the messages useful?

3) Compilation speed. How quickly does it turn a source file into an object file?

4) Output code speed. How fast do the output code files run?

5) Output code efficiency. How large are the output files?

6) Extensions to the ISO Standard. What extensions are present? What is missing? Are the extensions implemented rationally and designed for usefulness?

7) Program fragmentation. Does each compiler allow a large program to be broken down into smaller units? Modules? Chaining? Overlays? How much trouble is it? How much does fragmentation affect the efficiency of the program?

8) File I/O. Is file I/O at least up to the ISO Standard? Is there random file support? Untyped file support? How fast is the file I/O? What about error detection?

9) Real number handling. How are reals handled? What precision is available? Is the IEEE standard format for real numbers followed? Is there 8087 support? How fast are operations that use real numbers.?

10) Low-level machine hooks. Are facilities available to do system-level work? Can machine memory be accessed? How about machine I/O ports? Is there data-type conversion? Interrupt procedures? ROM call support? DOS call support?

A Few Notes on Benchmarks

A compiler benchmark is an attempt to say, "All other things being equal, this compiler performs this well doing [task]." The problem is, all other things are not equal and never can be, using different compilers. To keep your impressions of the benchmarks in perspective, you should be aware of our methods and some worrisome details.

Only MT+86 and MS Pascal have a TIME verb that returns a time value from the PC's internal clock. Thus, the PC's clock could not be used to time the code speed of the benchmarks. Instead, an ordinary hand-operated stopwatch was used. The calculation portion of each benchmark (except for the 10 x 10 matrix multiply) was run through at least ten times during each timing, so that the inevitable human reaction time was reduced by a factor of ten. For benchmarks that perform a single iteration in less than ten seconds, 100 iterations were actually timed.

But since the code speed of all compilers was timed identically, the relative performance of each compiler to the others is unaffected by the timing method. We turned off all debugger and run-time range-checking options of which we were aware. The problem is that some of the documentation is so bad that we might have missed some options. If you duplicate our benchmarks and find that they will run faster by tweaking compile/link options, not code, we would like to know.

Timing compilation was a little more precise. We set up batch files for each compile that included a call to PC DOS's TIME command before and after the compile and link operations. A typical batch file looked like this:

```
TIME 0:0:0
MT86 B:TRIGTEST $RBTB
LINKMT B:TRIGMT=B:
   TRIGTEST, TRANCEND/S,
   FPREALS/S, PASLIB/S
TIME
```

The first TIME command zeroes the PC's real-time clock, so that the second TIME command returns a fairly good figure for the time the whole batch file took to execute.

The exception was Turbo Pascal, which requires that the source file be resident in memory before it can be compiled. Turbo compiles so differently (it is a one-pass compiler that goes directly to a .COM file and does not produce a linkable, relocatable file) that its compile times can't be compared to the other three compilers. We could not use batch files to compile with Turbo, so we reverted to the stopwatch. Yes, Turbo is fast, but it takes shortcuts.

The speed of any benchmark that includes disk I/O is to some extent dependent on room temperature. A cold disk drive turns just a little bit more slowly—and with many disk accesses, this adds up.

To provide some general means of comparison between our field of Pascal compilers and the field of C compilers previously reviewed in *PC Tech Journal*, we translated to Pascal the "Pentathlon" benchmark (listing 1) used in "C and the PC: Part 1," (November/December 1983, page 110). In order to test some real number and transcendental math, we added a simple trigonometry benchmark (listing 2) that calculates 100 tangents, and a matrix multiplication benchmark (listing 3) that inverts a 10 x 10 matrix. To round out the set we included Eratosthenes' Sieve (listing 4). See table 2 for benchmark results.

In the matrix multiplication program, reprinted in listing 3 from *Pascal Programs for Scientists and Engineers* (Alan R. Miller, Sybex, 1981), we modified constants RMAX and CMAX so that each was equal to 10. We timed only the procedure that actually performs the matrix multiplication, and not the procedure that fills the matrix or the procedure that prints the results to the screen.

Although we felt the need for a good file I/O benchmark, we could not come up with reasonable code that would compile identically on any three of the compilers, much less all four. File I/O is one area where the four compiler writers really went their own separate ways. Comparing the speeds of four different custom-written programs, each purporting to do the same job, could be misleading. We'll give you a general idea of relative speeds, but in fairness we cannot offer hard numbers to back up our findings.

DOCUMENTATION

Why is language-compiler documentation so uniformly awful? We consider it a scandal: of the four user guides we reviewed, only one

Table 1: Compiler Features Comparison

COMPILER:	MS	MT+86	SBB	TURBO
COSTS:	$350	$400	$350	$49.95
VERSION:	3.2	3.2	2.0	1.0
8087 support	Yes	Yes	Faulty	No
Absolute variables	Yes	Yes	No	Yes
Chaining	No	Yes	Yes	Yes
Conformant arrays	No[1]	Yes	Yes	No
CP/M-86 version	No	Yes	No	Yes
Debugger	No	Yes	Yes	No
DOS 2.0 file support	Yes	No	No	No
DOS call support	Yes	Yes	No	Yes
Dynamic strings	Yes	Yes	Yes	Yes
Function/procedure parms	Yes	Yes	Yes	No
GET/PUT	Yes	Yes	Yes	No
INLINE	No	Yes	No	Yes
Interrupt Procs	Yes	Yes	No	No
Length of FP reals (bytes)	4/8	8	8	6
Long integers	Yes	Yes	No	No
Mark/Release	Yes	Yes	Yes	Yes
Modules	Yes	Yes	Yes	No
New/Dispose	Yes	Yes	Yes	No
Overlays	Yes	Yes	Yes	No
Port I/O	No	Yes	No	Yes
Random files	Yes	Yes	Yes	Yes
Recursion	Yes	Yes	Yes	Yes
ROM call support	No[2]	No	Yes	Yes
Screen Editor	No	+$200	Yes	Yes
TIME/DATE verb	Yes	Yes	No	No
Untyped files	No	Yes	No	Yes

NOTES:
[1]MS Pascal has a "super type" feature that allows variable array bounds. It is not compatible with true conformant arrays.
[2]MS Pascal evidently has undocumented and unsupported ROM call routines in its library.

Table 2: Compiler Benchmark Results

COMPILER:	MS	MT+86	SBB	TURBO
COSTS:	$350	$400	$350	$49.95
VERSION:	3.2	3.2	2.0	1.0
BENCHMARK:				
TRIGTEST				
Compile/link time				
w/o 8087:	2:30	1:52	1:11	0:06.4
with 8087:	2:11	1:47	1:09	n/a
Code size (bytes)				
w/o 8087:	32568	15872	9728	9074
with 8087:	23564	12288	8064	n/a
Code speed per iteration				
w/o 8087:	0:07.4	0:42.8	0:42.3	0:08.9
with 8087:	0:00.190	0:00.155	failed	n/a
10 x 10 MATRIX MULTIPLY				
Compile/link time				
w/o 8087:	3:09	2:03	1:39	0:09
with 8087:	2:55	1:59	1:34	n/a
Code size (bytes)				
w/o 8087:	37288	18432	12032	10317
with 8087:	29954	16384	10368	n/a
Code speed per iteration				
w/o 8087:	0:01.54	0:09.91	failed	0:02.7
with 8087:	0:00.41	0:01.10	failed	n/a
ERATOSTHENES SIEVE				
Compile/link time	1:53	1:49	1:20	0:04.3
Code size (bytes)	19960	11776	9344	9149
Code speed per iteration	0:01.11	0:01.95	0:01.54	0:01.55
PENTATHLON				
Compile/link time				
w/o 8087:	2:59	2:08	1:33	0:10.7
with 8087:	2:42	2:04	1:31	n/a
Code size				
w/o 8087:	29400	15872	10368	10317
with 8087:	22700	14336	8704	n/a
Code speed				
I. Floating point test				
w/o 8087:	0:01.93	0:15.12	0:02.92	0:03.51
with 8087:	0:00.217	failed	failed	n/a
II. Function calls	0:01.25	0:01.71	0:02.01	0:02.56
III. String copy	0:00.331	0:00.436	0:00.421	0:00.426
IV. Character count	0:02.28	0:05.14	failed	0:05.36
V. GET/PUT file copy on 30K file	1:48.3	0:62.1	0:38.3	n/a

NOTES:
All Turbo code files are .COM files; all others are .EXE files.
SBB compiled and ran the matrix multiply but filled the matrix with garbage.
SBB gives a run-time bounds error for CHR(*X*) where *X*>127.
Turbo does not have GET/PUT.

is even mediocre—the others range from moderately poor to abysmal.

Only the SBB Pascal manual makes any attempt to teach a new user the Pascal language. This is unfortunate, because much of Pascal's power lies in its compiler-specific extensions—and only the compiler manufacturer can teach the beginner about the compiler itself. The manufacturers should have an obligation to provide a large (200+ page) tutorial on the Pascal language as implemented in their compilers.

MS Pascal's two manuals are the worst. They are big—the biggest of the bunch—and chaotic. These words all seem to be in Brownian motion. MS Pascal is a compiler of awesome power—if you can find and decipher the magic words to make it go. A huge amount of detail is provided, in no rational order, and finding the detail you want is close to impossible. A canny hacker tends to become "one" with his compiler after living with it for a few months—and MS Pascal is no exception—but what of the beginner? Although the manuals are typeset, and production quality is good, the MS Pascal user guides may be the most frightening documents this side of The Land of Mainframes.

The manuals offer a few examples—but only a fraction of what is needed. *Every* keyword, built-in procedure or function, compiler toggle, and linker toggle should have an example—most especially compiler-specific features that are not covered in Pascal textbooks.

Each of the two manuals has a good index—fortunately. Without them the text would be impenetrable. Printer support is not mentioned in either index.

The writing is as dry as the Gobi desert, and it doesn't have to be that way. The SBB manual has a definite human touch that is completely lacking here. Our suggestion to Microsoft would be to write one more manual of about 180 pages, taking a computer literate (but non-expert) person through the language one feature at a time, with abundant examples, a few diagrams, and maybe a little humor to take some of the weight off.

We recommend *Personal Pascal* by David E. Cortesi and George W. Cherry (Reston, 1984) as a good companion to MS Pascal. With more detail on compiler specifics, that book could fill in the gaps in the factory documentation.

Next to worst by a nose is the documentation for Pascal/MT+86. It takes an opposite tack: it is skeletal to the point of being incomplete. Like Microsoft's manual, MT+86's documentation is in two parts: a Pascal/MT+ Reference Manual that describes the syntax common to all versions of the compiler, and a Programmer's Guide that is specific to

a particular implementation, in this case for 8086/PC DOS.

All told, about 250 physical pages are provided, but there are only about 120 full pages worth of information. Most of the Reference Manual consists of descriptions of language features, one per page, often with as little as 30 words and a one-line example.

This is not enough. Oddly, Digital Research dropped Pascal's BNF (Backus-Naur Form) definition diagrams when it made up its most recent, slipcase-bound manuals. BNF diagrams are not easy to read, but they are the only way available to describe the syntax of a language compiler unambiguously. They are not used often—but when they are it is because they are needed.

Both manuals are typewritten, with occasional typeset headers. Production quality is not high. Some of the memory map diagrams have no captions at all, so the reader is never sure to which one the text is referring. The index is only fair: "enumerated type" is not present. We looked high and low for "printer support" or "printer device" or "printing text." Nothing. Finally we found it mentioned under "device names." A person unfamiliar with operating system jargon could grow old and die trying to figure out how to send text to the printer from within an MT+86 program.

The READ.ME file for release 3.2 contains many corrections for the manual. These errors should have been caught by simple proofing of the galleys long ago. With all the corrections penciled in, it looks like the first draft.

The only redeemable feature that makes MT+86's manuals usable is that their sparseness and reasonably large print allow successful skimming. If they were as verbose as MS Pascal's manuals, they probably would be unreadable.

Turbo Pascal's manual is a little better. First of all, it is typeset from start to finish, which allows smaller print to be readable without molesting the eyeballs. On the other hand, it cannot be made to lie flat on a desk and it will not stay open to a particular page unless held open. The binding is very tight and cracks if opened very far. Binding the manual as a paperback book helped keep the price down, and for a $49.95 compiler it is an acceptable tradeoff. But the user will probably spend a lot of time with one hand holding the manual open and the other picking away at the keyboard. The best option would be to find somebody with a bandsaw and literally cut the spine off, free up the pages, punch them, and drop them into a three-ring binder.

The quality of the writing in Turbo Pascal is better than either MS Pascal's or MT86's; it is more grammatical and less technical. Someone who knows Pascal should have no trouble curling up with the manual and reading it from cover to cover in a couple of hours. It is reasonably well organized and seems fairly complete. A beginner, however, should prepare to do a lot of digging and flipping and skimming—and head scratching.

The index suffers from a failure common to the other three compilers' user guides: key words that a beginner would look for are not always there. Once again, "printing" and "printer support" are not in the index. To find out how to access a printer fom Turbo the user must look under "device names." Index entries are cheap—there is no reason not to have triple or quadruple redundancy if it helps to find an explanation in the manual quickly.

The Turbo manual includes BNF diagrams and good explanations of compile and run-time error messages. It also had a number of errors and some truly peculiar explanations here and there, but these usually can be figured out with a little experimentation.

With some attention, this could become a first-class manual. Considering the $50 price tag of the compiler, the Turbo manual is not bad.

The SBB Pascal user guide is the best of the bunch, which isn't to say it's terrific. It is friendly and demonstrates that a great deal of thought went into the construction of the compiler it describes.

The SBB Pascal user guide is the best of the bunch, which isn't to say it's terrific. It is friendly and demonstrates that a great deal of thought went into the construction of the compiler it describes.

It is a typewritten, 510-page, loose-leaf manual in a slipcase binder. The production quality is not high, but the type is large and the margins wide, making for a great many pages that can be easily skimmed. Another welcome touch (especially with 500-plus pages) are the index tabs calling out important sections such as "Compiler Operation," Debugger," and "Index." Our copy was a V1 manual with a V2 addendum tacked onto the front. This made organization and detail-location suffer, but once V2 information is melted into the main text, that problem will go away.

The index is so-so. Once again, "printer" is not listed, nor is "de-

vice," nor any hint about where one might find out how to send text to the LST: device. Most everything else we looked for was present.

SBB's manual is the only one that mentions the how and why of code optimization. It was instructive to weigh that information against the compiler's tight, fast code.

A beginner will find this manual the most approachable of the four compiler user guides.

Ease of Use

No one likes swapping disks around. A compiler that fits on a single disk is good; one that leaves room for all the libraries is great; one that can also hold the linker is terrific; and one that, on top of everything, leaves room on disk for a text editor is nirvana. Of the four compilers, only Turbo is nirvana, but SBB comes close. If you don't need the 8087 library, you can fit all of SBB on a double-sided DOS 2.0 disk, including its screen editor.

None of the compilers is hard-code tied to drive A: à la WordStar, thank goodness. All may be run from a RAM disk, though for the benchmark timings we stayed with physical diskettes. Running from a RAM disk saves a good deal of time, especially with an overlaid compiler like Pascal/MT+86.

If documentation considerations are excluded fom the ease-of-use question, MS, MT+86, and SBB are about neck and neck. Each requires a separate step for compiling and for linking. None leaves room on a single disk for any substantial text editor. MS and SBB have two separate passes that must be invoked separately, while MT+86 runs the entire compile to relocatable object file from one compiler invocation.

If the user does not enter all the required parameters from the command line, MS Pascal will prompt for them. That's a nice touch while the user is still trying to remember what the parameters are and in what order they must be typed. SBB Pascal and MT+86 Pascal simply abort if all required parameters are not present in the command line.

And then there is Turbo Pascal. Turbo is set up rather like the UCSD p-System (though the p-System certainly is not as fast). When Turbo comes up, it presents a menu of tasks, which are chosen by letter. The command letter is highlighted for mnemonic purposes within the command itself so there never is any doubt as to what to type. This menu will come up anytime a "?" is typed. Turbo has its own editor always in memory, right along with the compiler. To compile, touch C, and, whoosh, it compiles. To edit the source code, touch E, and, wham, it's in the text editor. If the compiler discovers an error of some kind (either compile time or run time), zip, it returns to the editor, and Turbo's cursor comes to rest where the compiler thinks the error is. Now *that* is ease of use.

Turbo falls down a little when it is asked to compile a program too large to be entirely resident in memory. A method for daisy-chaining source files through RAM is not immediately obvious, but it can be figured out. Some people detest WordStar (Turbo's text editor uses a subset of WordStar's commands) and hate its command structure. Turbo lets those people redefine the control key presses that activate its commands. This redefinition doesn't always seem to work. The configuration code appears to have a couple of bugs in it. For those users who intend to redefine Turbo's editor commands, beware. Funny things may happen.

Pascal/MT+86 has an enhancement package called SPP (Speed Programming Package) to do for MT+86 what Turbo's editor/error-finder does. It costs an extra $200, however, so we do not consider it part of the compiler and will not review it here. It does work well, and if you use MT+86 a lot SPP is worth the extra money.

Overall, MS Pascal is the most difficult to use, followed by SBB, followed by MT+86. But Turbo Pascal is so far ahead of all three of them that fair comparison is impossible. Turbo is just an entirely different way of writing programs.

Compilation Speed

Refer to table 2 for the numbers on compilation speed. They speak for themselves. All these timings (except Turbo's) can be much reduced by compiling from a RAM disk.

Turbo Pascal, once again, works differently from its brothers, which must be understood to evaluate the benchmarks fairly. MS, MT+86, and SBB compile from disk to disk; Turbo compiles either from RAM to RAM or from RAM to disk. The benchmark compile timings for Turbo were all done from RAM to disk, Turbo's worst case.

Because Turbo doesn't have to wait for a slow physical disk to find its source and intermediate files (it does not in fact generate any intermediate files) one might think it only seems faster. But when SBB was run from RAM disk to RAM disk, Turbo still outran its first compile pass by a factor of four. Turbo does not allow linking of library files with its object files, giving it another built-in speed advantage. Lack of modular compilation is, perhaps, a high price to pay for speed. That particular decision we will leave to the user. For us, at least, Turbo takes the cake and candles for small (fewer than 600 lines) programs. SBB is runner-up. MS Pascal is quite slow in compiling, but the tradeoff is a tremendous amount of compiler power and very fast code.

One odd note on Turbo: Turbo code files always perform one PC ROM call before executing (to clear the screen) and, therefore, programs compiled with Turbo will crash many PC "compatibles." We found no way to turn this "feature" off. A generic MS DOS version that does not do this is available, but we have

not seen or tested it. PC Turbo itself will not run on any but truly ROM-compatible machines, such as the Compaq and Columbia. We have watched it crash the Zenith Z100, Victor 9000, and Sanyo MPC.

OUTPUT CODE SPEED

MS Pascal is the clear winner in the code speed arena, as shown in table 2. Its real number support is blindingly fast. MS Pascal only falls behind in the area of file I/O. Pentathlon #5 is representative of file I/O in general for MS, MT+86, and SBB. What took SBB a half-minute and MT+86 a whole minute took MS a minute and a half.

GET and PUT are worst cases. Almost any other kind of file I/O is faster. In particular, random file I/O using some SEEK verb is fast compared to sequential GET and PUT.

The slowpoke award goes to Pascal/MT+86, especially in the area of non-8087 real numbers. Most of MT+86's problems are the result of its run-time support being written in Pascal rather than pure machine code; and that, in turn, is a result of its translation from the 8080/Z80 world.

OUTPUT CODE EFFICIENCY

How big are the code files needed to do a particular job? Table 2 tells nearly the whole story. Be aware that Turbo Pascal (again, the odd man out) creates only .COM files, which are inherently smaller than the .EXE files that are produced by the other three compilers.

MS Pascal produces inexplicably massive code files. The MS code optimizer seems to bend all its efforts toward speed and lets the code files grow as large as they must to produce the fastest code. All MS Pascal code was compiled with the /Q flag asserted, which is supposed to turn off code generation of run-time error and debug support.

Code compiled to take advantage of the 8087 always makes for somewhat smaller code files. In order to support IEEE-format real numbers, the software must either find and use an 8087 chip in the hardware or emulate one in software—and the emulation overhead adds significantly to the code bulk. For small programs this might mean that code size would be reduced by 20 to 25 percent with an 8087.

Certainly the best balance of code speed and code size is seen in SBB Pascal, which is faster than all but MS Pascal and produces code files smaller than all but Turbo.

EXTENSIONS TO THE ISO STANDARD

Pascal is close to worthless without a whole suite of extensions. The number of extensions a compiler has and how well they are implemented can make or break it.

Perhaps the most important extensions to the ISO Standard are strings and string functions. All four compilers support variable-length strings. MT+86 and Turbo handle strings almost identically, including string functions, and both mimic the UCSD p-System way of handling strings. Turbo also has BASIC's STR and VAL functions, a necessary and nice touch.

SBB and MS Pascal each have a proprietary method of declaring string variables and a proprietary collection of string functions. MS Pascal strings fall under the truly peculiar "supertype" concept, and they are hard to deal with. A super array is how MS Pascal implements the idea of conformant arrays—that is, arrays not explicitly bounded at compile time—but it is badly documented and hard to understand. Since MS strings are super arrays, they fall into the same undocumented mud. SBB strings are easier to understand, but their string functions are not as well implemented as MT+86's and Turbo's.

The slowpoke award goes to Pascal/MT+86, especially in the area of non-8087 real numbers. Most of MT+86's problems are the result of its run-time support being written in Pascal rather than pure machine code.

The next important extension to the ISO Standard is modular compilation. Only Turbo lacks this extension, which is really a function of not producing linkable object modules. None of the compilers or linkers does "interface" checking across module boundaries. If the invocation of a procedure does not match the procedure's declaration in its module, the linkers simply butt the two together and hope for the best; what happens in the event of a mismatch is usually a crash.

MS Pascal's scheme of modular compilation is excellent and reminiscent of Modula 2, in that a module has a declaration part (containing the function/procedure declarations) and an implementation part (containing the procedure code itself). It is, however, hard to grasp from the ultra-dense documentation exactly how to use this feature.

All four compilers implement ELSE or OTHERWISE statements in a CASE statement.

They all allow free union variant records, but the user guides do not explain what they are. Free union variants are a "back-door"

way of allowing a single variable to exist as two different types, to form a "bridge" between the two types. MS Pascal warns the user if he declares such a variant, but it will not forbid using them. MS Pascal also has a RETYPE function to accomplish a similar philosophy of defeating strong typing without defining an entirely new record type.

MT+86 and MS Pascal have long integer types that occupy four bytes instead of two. MT+86's LONGINT type cannot index an array and is limited in other ways. But it can hold a big integer.

Turbo Pascal includes a set of text CRT control functions that allow *XY* cursor positioning, screen and line clear, cursor movement, and so on. It is infuriating that the other compilers cannot provide a library of these functions. MT+86 doesn't even provide a means of calling the video routines in ROM. Score one big one for Turbo.

PROGRAM FRAGMENTATION

Writing large programs with high-level language compilers is easy. Once the program no longer fits in available memory, you break it either into chunks that chain from one to another or into overlays that share the same region of memory.

MS Pascal lacks chaining completely. It compensates somewhat by being the only compiler of the four that supports code segments larger than 64K. Linking a program as large as 300K is possible, according to the manual. The latest release of MS Pascal (3.2) has a simple overlay scheme to allow a single overlay area. Its advantage is that it is very easy to use—the linker takes care of all code and data allocation. The user must relink the entire program any time he changes either the root or any of the overlays, and a routine in one overlay may not call a routine in another overlay.

MT+86 is limited to a single 64K code segment, but it allows both chaining and overlays, and its overlay system is excellent. The user can change an overlay and relink only the overlay, without having to relink the entire program. With a program that has 70 overlays and 200K of code, this is important. MT+ overlays can call routines in other overlays. It is a complicated system that involves manual allocation of code and data (the user must tell the linker where all code and data segments begin and how large they are) but it allows 16 overlay areas and 255 overlays.

SBB also has both chaining and overlays. Its overlay system is much like that of MT+86, except that overlay routines cannot call routines in other overlay files.

Turbo lacks overlays but does provide chaining.

FILE I/O

Comparing file I/O performance among the four compilers was hair-tearingly difficult. Each compiler has its own quirky way of handling files, and in the end we dropped all of our experimental benchmarks on the grounds that it isn't fair to compare performance of code "tweaked" to fit an individual compiler.

All that remains is Pentathlon #5, which is essentially a GET/PUT copy of one file to another, character by character. Turbo lacks GET and PUT, and its file system has numerous other peccadilloes. We tried to replace GET and PUT with READ and WRITE and found it ran Pentathlon in 253 seconds—it seemed to "sleep" for a second or two between disk accesses.

All four compilers support random file I/O. MS and Turbo use a SEEK verb to position the head to an individual record, whereupon a separate GET or PUT must be executed. MT+86 combines SEEK and READ/WRITE into one pair of verbs, SEEKREAD and SEEKWRITE. SBB uses a special form of READ and WRITE for random I/O.

As in Microsoft BASIC, emulating sequential file I/O with random file I/O is almost always faster (and sometimes by the whole nine yards) than actual sequential file I/O. SBB file I/O is probably the fastest of the bunch, though the spread is nowhere near as wide as it is for real number performance. MS Pascal is unaccountably the slowest of the four in terms of file I/O.

MT+86 and Turbo both have "block" file I/O features that allow high-speed access to any file, regardless of the file's type. BLOCKREAD and BLOCKWRITE deal in raw disk sectors and pay no attention to record field boundaries or variables. The user can load a buffer with them and interpret the buffer in his own fashion. This feature is very fast but of limited usefulness.

Overall, MT+86's file I/O is the most standard and versatile, but SBB's seems a good deal faster. Turbo's is nonstandard and needs work. MS Pascal's is just plain slow.

REAL NUMBER SUPPORT

Real numbers are a real pain from a computational standpoint. Transcendental numbers and repeating decimal fractions are hard to represent in a binary world. All the complicated gyrations a computer must do to approximate real numbers take a great deal of time, and every machine cycle counts.

Complicating matters is the fact that MS, MT+86, and SBB store real numbers as 8 bytes (in an IEEE standard format), while Turbo stores its reals as 6 bytes. Operations on 6-byte reals are inherently faster than on 8-byte reals, but a penalty is paid in range and precision.

On the other hand, the user whose calculations never quite reach as high as 10 to the 307th power might take the speed of a 6-byte real and be glad for it.

SBB turned in a peculiar and troubling performance on the 10 x 10 matrix multiplication. All four compilers compiled identical source on this benchmark, but although MS, MT+86, and Turbo

ran the program correctly, SBB filled the matrix with garbage. We have not yet determined why, but it points to a serious bug somewhere in the SBB code generator. Along with the SBB package we received an update on its floating-point linkable library and used it; evidently even the update didn't catch all the gremlins in the floating point support.

What is much worse is that the 8087 support for SBB Pascal did not work at all. With SBB we were unable to create an 8087-capable code file that did not immediately display an error message upon the first call to the 8087 hardware.

SBB's user guide states at one point that its reals are stored as 8 bytes, but at another point it says reals are stored as 4 bytes. We are fairly sure they are in fact 8-byte reals and wonder what this confusion means. Real numbers are definitely the Achilles' heel in SBB's otherwise excellent compiler.

MT+86 real-number support is slow. According to a reliable source, all MT+86 real-number support is itself written in Pascal rather than machine code, and this would certainly make a difference. Perhaps the worst part of MT+86 real support is screen display of real numbers; the ponderous slowness of the process must be seen to be believed.

MS Pascal's real-number support is magnificently fast—faster than Turbo, which uses a smaller real-number format. Using MS Pascal without an 8087 is almost as fast as using MT+86 *with* an 8087.

Turbo's 6-byte reals are almost faster than two fewer bytes would seem to allow. Unless the user's needs for range or precision exceed those of 6-byte reals (and until recently most real numbers were done in 4 bytes) Turbo is the best number cruncher for the money.

All compilers except Turbo have 8087 support libraries. The difference in execution time, especially for transcendental functions, is nothing short of phenomenal: TRIGTEST ran 282 times faster under MT+86 using the 8087 than it did without the 8087. Now that's accelerated math.

Note that code files incorporating 8087 math are smaller and compile and link more quickly than programs without 8087 support. Not having an 8087 forces the run-time code to emulate an 8087, which means more code and slower code.

> *All four compilers allow DOS calls, although none documents them very well.*

LOW-LEVEL MACHINE HOOKS

Perhaps the most important low-level compiler features are operations on the bit and byte level: setting, clearing, shifting and rotating bytes, and bitwise logical operators. All four compilers are fairly complete in this regard. SBB has the best support by a nose. It is the only one of the four compilers that can rotate a byte in addition to shifting it. MS Pascal also includes 16- and 32-bit modulo arithmetic as a collection of functions that return carry rather than flag an overflow error.

Operating system access is also important. All four compilers allow DOS calls, though none documents them especially well. Turbo and SBB include a means of calling ROM routines like VIDEO—but both take an inordinate amount of time to figure out. SBB's otherwise good manual simply says: "The file CALL.ASM also includes a BIOS call routine." By reverse engineering a sharp hacker might be able to figure out how the routine works. The rest of us will have to wonder why these functions are such well-kept secrets. Rumor has it that MS Pascal has a VIDEO call routine, but it was found only by probing the run-time library with DEBUG.

No routine is provided to call ROM from MT+86. Because this is the only way to control the CRT under PC DOS, the lack of such a routine is unfortunate.

Turbo solves the need for direct memory PEEK and POKE elegantly: it treats all of RAM as one long array with the predefined identifier MEM as its name. To peek at an address, simply write:

CONTENTS:=MEM[SEG:OFF];

which is pretty slick. Turbo, MS, and MT+86 also allow "absolute" variables that are ordinary variables given a specific address in memory, which may or may not be related to the location of the program itself. This is useful for setting up screen buffers as arrays and accessing standard reserved memory locations.

Turbo includes a complete library of CRT control routines. GOTOXY, CLREOL, CLREOS, and others are there and ready to use. Nobody today will use a program that does everything "scrolled from the bottom" as in the bad old days. Certainly the IBM PC standard for ROM calls would warrant a library to do the job. Turbo gets a big gold star for this indispensable feature.

MT+86 and Turbo have an INLINE verb that allows creation of short, hand-assembled machine code routines or fast, compile-time tables. It's a shame hand-assembling 8086 code is such a delight, or this feature would be more useful.

Both MS Pascal and MT+86 allow the writing of interrupt procedures. Neither documents this feature well and only MT+86 attempts to provide an example of its use. We have never been able to make an MT+86 interrupt routine do more than bring the system down in flames. Whether it's bugs or misunderstanding is unclear.

MS Pascal has routines that sup-

port multitask or multiuser access of files—awaiting the day when PC/MS DOS supports multitasking.

MS Pascal's library is full of intriguing functions for low-level machine access—too many to list here.

Overall Evaluations

Getting to know a Pascal compiler takes a good long time, longer than any pair of hackers with a deadline has to play with. So we feel uneasy making blanket statements about compilers we have worked with for only a few weeks. Nonetheless, here are our evaluations on the four compilers under discussion here:

MS Pascal: This is a big, powerful, complicated compiler. Its complexity was overwhelming at times, made worse by our fast-approaching deadline and its nearly unreadable documentation. It is easily the most powerful compiler of the lot, especially now that the new release 3.2 has the germ of a good overlay facility.

It does just about everything, and does it fairly well. Furthermore, the compiler has a lot of third-party support in the form of utility libraries for graphics, KSAM, screen forms, and other necessary applications bootstraps. Interface to the excellent Microsoft Mouse is easy, whereas we have not yet doped it out for the other compilers. Unlike Pascal/MT+86, it can interface to good assemblers like Microsoft's Macro-86, and again, unlike MT+86, it uses a standard, widely supported relocatable object format.

And for those who are into windows, guess which Pascal compiler is going to be the first to support Microsoft Windows?

With the notable exception of file I/O, it produces code files that, while obese, are blindingly fast. Its support for modular compilation is the best of the four, and its low-level hooks are many and only (mysteriously) lacking in port I/O. It is also the only compiler of the four that supports DOS 2.0 nested disk directories.

MS Pascal is disk-space hungry, awkward to use, and hard to learn. But if the user has time to live with it for awhile and dope out its quirks, it can do an awesome job.

Pascal/MT+86: Digital Research's compiler suffers somewhat from having grown into PC DOS from other pastures: it uses a unique, relocatable object format, which means that you cannot link its code with code produced by any other assembler or compiler. It includes an assembler, which is essentially undocumented, so moving from MT+86 to assembler is frustrating. Its run-time support is written in Pascal for portability, and, thus, is rather slow.

These limitations are going away, according to DRI. The company is rewriting the compiler from the ground up, to remove any lingering mementos of its 8-bit heritage. The new MT+86 will support the advanced features of the iAPX286—which makes it well worth watching for.

Without an 8087, MT+86 real-number support is painfully slow.

The strengths of MT+86 lie in its extensions. Its overlay system is unexcelled: You can change and relink an overlay without relinking the entire program. This is important in an application with 50 overlays containing 200K of code. Its low-level system hooks are quite complete and easy to use. It has a good symbolic debugger and a choice of real-number formats.

For doing really big work, there is simply nothing else.

SBB Pascal is, on balance, one pretty fine compiler. It has a superior user guide, a complete set of extensions, and includes a screen editor and ASCII source for most run-time routines.

Its overlay support, while not as versatile as MT+86's, is reasonably good. SBB has serious problems with real numbers—the manual does not agree with itself on how large they are, and the matrix multiplication benchmark simply doesn't work. It filled the matrix wih trash when the identical source compiled and ran correctly with the other three compilers. Worse, its 8087 support does not work at all.

Software Building Blocks is aware of the problems that we discovered in version 2.0 of the compiler. The company has assured us these problems will be corrected in version 3.0, which should be available by the time you read this.

Certainly, SBB has been supporting this package—it came to us with a host of updates and bug patches—and time should polish it further. Its code files are already very small and extremely fast, and it compiles more quickly than any other compiler save Turbo (which cheats, remember).

SBB Pascal has the look and feel of a product that just hasn't quite jelled yet. As soon as the real numbers work correctly, this compiler can be recommended as useful and efficient. But reals are important in Pascal, so we say be cautious—and perhaps wait for the next release.

Turbo Pascal: How did Borland pull this one off: a complete, competent, (almost) bug-free native code compiler with its own screen editor and a horde of juicy extensions that fits in 33K and still costs only $49.95?

But it's real. And it's real fast, relatively simple—too simple to cripple with clunky documentation. Pascal was meant to be simple so students could approach it. In this sense, Turbo is truer to Pascal's original purpose than any other compiler. It is *the* compiler for students and newcomers to Pascal.

Titanic programs are beyond its capabilities; it doesn't know what modules or overlays are. But with its built-in ROM call routine and CRT controls Turbo is a natural for small-to-middling applications. It has no 8087 support, but its real number operations are fast. And

Turbo has many low-level system hooks, including INLINE for bargain basement assembler interface, and shift functions, absolute variables, free union variant records, and more. Its user interface leaves the others in its dust.

But best of all, this is a "Volks-Pascal"—it costs $50 and comes in a cardboard box. No glitzy binders, no plastic museum cases that break.

Turbo is a winner. Haul out the big guns for the big game—and use Turbo when you need to work small, fast, and smart.

Every one of these four compilers has it strengths. Each has one or more nasty flaws: MS Pascal has severely limited program fragmentation and documentation as dense as granite; MT+86's real numbers are slowwwwwwww; SBB's real numbers don't always work; and Turbo takes some unnecessary liberties with the ISO Pascal Standard.

What all have in common is a sense of being works in progress. New releases of MS Pascal, SBB, and MT+86 have occurred recently. DRI has admitted that it is rewriting MT+86 from the ground up to make efficient use of the iAPX86 family architecture, and a reliable rumor has it that Turbo Pascal (which is selling at the rate of 300 copies per day) is being reworked into something truly awesome—and still costing only $50. Considering some of the screwball compilers that have come across the transom for C and FORTRAN, Pascal presents an amazingly good field from which to choose.

Choose carefully.

But choose Pascal.

MS Pascal
Microsoft
10700 Northup Road
Bellevue, WA 98004
800-426-9400
$300.00
CIRCLE 464 ON READER SERVICE CARD

Pascal/MT+86
Digital Research
P.O. Box 579
Pacific Grove, CA 93950
408-649-5500
$600.00
CIRCLE 463 ON READER SERVICE CARD

SBB Pascal
Software Building Blocks
P.O. Box 119
Ithaca, NY 14851
607-272-2807
$350.00
CIRCLE 462 ON READER SERVICE CARD

Turbo Pascal
Borland International
4807 Scotts Valley Drive
408-438-8400
$49.95
CIRCLE 461 ON READER SERVICE CARD

Update: Turbo Pascal

Due to deadline pressures, we were unable to include verified information about Borland's 2.0 release of Turbo Pascal. We did obtain a production copy of the product, however, and have seen the new features. Because of the intense interest in the product, and a few of the comments in this review, we feel compelled to mention the features Borland has added to the product. The price of the standard version remains $49.95.

- *Overlay support has been added. In true Turbo style, the support is simple and to the point.*
- *Heap management has been improved by adding standard Pascal's DISPOSE procedure, the FREEMEM procedure, and the MAXAVAIL function.*
- *IBM PC Turbo now supports graphics, colors, and sound. Reserved words have been added for the display modes and the 16 standard colors.*
- *A windowing feature that uses the scrolling routines present in the PC's BIOS is new. It is not a full window manager, however.*
- *8087 support has been added, but it is an extra cost option. $89.95 buys a disk with both the 8087 version and the standard version.*
- *Two new functions, WHEREX and WHEREY, return the coordinates of the screen cursor and round out the built-in screen management functions.*
- *New navigational commands have been added to the editor; but as mentioned in the article, it is still awkward to configure.*

—WF

Listing 1 PENTATH.PAS

```
{
     The Pentathalon Program
     Translated from the C version of these routines
     by Michael Brian Bentley
     Originally written by Bill Hunt

     For PC-TECH Journal readers everywhere
}

program pentathalon;

type longchar = array [ 0..500] of char;


var  i, niter:     integer;
     ibench:       integer;

procedure bench1;       { floating point arithmetic benchmark }

var  i,j: integer;
     x,y: array[ 0..99 ] of real;
     z:   real;

begin
     for i := 0 to 99 do begin
          x[i] := i + 1;
          y[i] := 3 + i;
     end;
     z := 0;
     for j := 0 to 9 do
          for i := 0 to 99 do
               z := z + x[ i ] * y[ i ];
end;

procedure bench2;       { function calling benchmark }

var i: integer;

     procedure dummy( i: integer );
```

```
    begin
        i := i + 1;
    end;

begin
    for i := 0 to 19999 do
        dummy(i);      { EH? }
end;

procedure bench3;        { string copy benchmark }

var  i:        integer;
     s,s2:     longchar;

    procedure scopy(var target: longchar; origin: longchar);

    begin
        target := origin;   { oh hum }
    end;

begin
    for i := 0 to 499 do
        s[ i ] := 'a';

    s[ 500 ] := chr( 0 );

    for i := 0 to 99 do
        scopy( s2, s );
end;

procedure bench4;        { character count benchmark }

type shortchar = array [ 0..127 ] of integer;

var  i:   integer;
     s:   longchar;
     cnt: shortchar;

    procedure count_chars(var strng:longchar;var counts:shortchar);

    var  i:   integer;
         c:   char;
         idx: integer;

    begin { count_chars }
        i := 0;
        c := strng[ i ];
        while ( strng[ i ] <> chr( 0 ) ) do begin
            if ord( c ) > 127 then
                idx := ord( c ) - 128
            else
                idx := ord( c );
            counts[ idx ] := counts[ idx ] + 1;
            i := i + 1;
            c := strng[ i ]
        end
    end; { count_chars }

begin { bench4 }
    for i := 0 to 499 do
        s[ i ] := succ( chr( i ) );

    s[ 500 ] := chr( 0 );

    for i := 0 to 99 do
        count_chars( s, cnt )
end;

procedure bench5;        { file copy with getc/putc }

var  infile,
     outfile:  file of char;
     c:        integer;
     n:        integer;
     retval:   integer;
     ch      : char;

begin
    assign( infile, 'test.in' );
    assign( outfile,'test.out' );
    reset( infile );
    rewrite( outfile );
    if ( ioresult = 255 ) then begin
        writeln( ' Cannot open a file.' );
    end
    else begin
        n := 0;
        while ( not( eof( infile ) ) ) do begin
            n := n + 1;
            outfile^ := infile^;
            put( outfile );
            get( infile );
        end
    end;
    writeln; writeln( ' ', n, ' characters' );
    close( infile, retval );
    close( outfile, retval );
end;

procedure makefile;      { create a test file }

var  victim:   file of char;
     n:        integer;
     retval:   integer;

begin { makefile }
    assign( victim, 'test.in' );
    rewrite( victim );
    if ioresult = 255 then begin
        writeln(' Cannot open test file. ');
    end
    else begin
        n := 0;         { pretty wierd, Bill }
        for n := 0 to 29999 do begin
            victim^ := 'a';
            put( victim )
        end;
        close( victim, retval )
    end
end;

begin { main program }
    writeln; write( ' Benchmark:' );

    readln( ibench );

    writeln; write( ' no. iterations:' );
    readln( niter );

    for i := 1 to niter do begin
        case ( ibench ) of
            1: bench1;
            2: bench2;
            3: bench3;
            4: bench4;
            5: bench5;
            6: makefile;
        end;
    end;
    writeln; writeln( ' thru.' );
end.
```

Listing 2 TRIGTEST.PAS

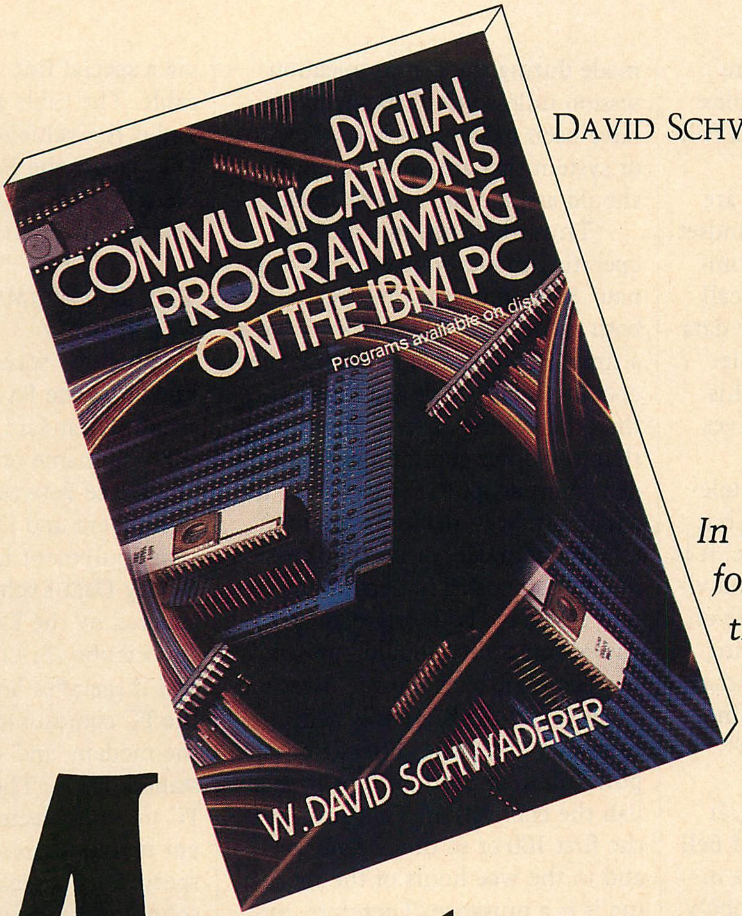
```
PROGRAM TRIGTEST;

VAR TANGENTS : ARRAY[1..100] OF REAL;
    R,T      : INTEGER;
    CH       : CHAR;
    RUNS     : INTEGER;

BEGIN
  WRITE('>>Enter # of runs to execute: ');
  READLN(RUNS);
  WRITE('>>Press (CR) to begin calculations: ');
  READLN(CH);
  WRITE('>>Beginning tangent calculations...');
  FOR T:=1 TO RUNS DO FOR R:=1 TO 100 DO TANGENTS[R]:=SIN(R)/COS(R);
  WRITELN('...all done!');
END.
```

Listing 3 MATRIX.PAS

```
PROGRAM MATRIX;

(* By Alan R. Miller *)
(* from: PASCAL PROGRAMS FOR SCIENTISTS AND ENGINEERS *)
(* (c) 1981 by Sybex, Inc. *)

CONST
  RMAX = 20;
  CMAX = 20;

TYPE
  ARY   = ARRAY[1..RMAX] OF REAL;
  ARYS  = ARRAY[1..CMAX] OF REAL;
  ARY2  = ARRAY[1..RMAX, 1..CMAX] OF REAL;
  ARY2S = ARRAY[1..RMAX, 1..CMAX] OF REAL;

VAR
  Y     : ARY;
  G     : ARYS;
  X     : ARY2;
  A     : ARY2S;
  NROW,NCOL     : INTEGER;
  CH    : CHAR;

PROCEDURE GET_DATA(VAR X : ARY2;
                   VAR Y : ARY;
                   VAR NROW,NCOL : INTEGER);

(* Get values for NROW, NCOL, and arrays X, Y *)

VAR I,J : INTEGER;

BEGIN
  NROW:=10;
  NCOL:=10;
  FOR I:=1 TO NROW DO
    BEGIN
      X[I,1]:=1;
      FOR J:=2 TO NCOL DO
        X[I,J]:=I*X[I,J-1];
      Y[I]:=2*I
    END
END;    (* GET_DATA *)


PROCEDURE WRITE_DATA;

(* Print out the answers *)

VAR I,J : INTEGER;

BEGIN
  WRITELN;
  WRITELN('       X                          Y');
  FOR I:=1 TO NROW DO
    BEGIN
      FOR J:=1 TO NCOL DO
        WRITE(X[I,J]:9:1,' ');
      WRITELN(':',Y[I]:9:1)
    END;
  WRITELN;
  WRITELN('       A                          G');
  FOR I:=1 TO NCOL DO
    BEGIN
      FOR J:=1 TO NCOL DO
        WRITE(A[I,J]:10:1,' ');
      WRITELN(':',G[I]:10:1)
    END
END;  (* WRITE_DATA *)

PROCEDURE SQUARE(X      : ARY2;
                 Y      : ARY;
                 VAR A  : ARY2S;
                 VAR G  : ARYS;
                 NROW,NCOL : INTEGER);

(* Matrix multiplication routine *)
(* A = transpose X times X       *)
(* G = Y times X                 *)

VAR I,K,L : INTEGER;

BEGIN  (* SQUARE *)
  FOR K:=1 TO NCOL DO
    BEGIN
      FOR L:=1 TO K DO
        BEGIN
          A[K,L]:=0;
          FOR I:=1 TO NROW DO
            BEGIN
              A[K,L]:=A[K,L]+X[I,L]*X[I,K];
              IF K<>L THEN A[L,K]:=A[K,L]
            END
        END;    (* L loop *)
      G[K]:=0;
      FOR I:=1 TO NROW DO
        G[K]:=G[K]+Y[I]*X[I,K]
    END         (* K loop *)
END;  (* SQUARE *)


BEGIN   (* MAIN *)
  GET_DATA(X,Y,NROW,NCOL);
  WRITE('>>Press (CR) to begin calculations: ');
  READLN(CH);
  WRITE('>>Starting matrix inversion..');
  SQUARE(X,Y,A,G,NROW,NCOL);
  WRITELN('..all done!');
  WRITE_DATA
END.
```


Listing 4 TESTSIEVE.PAS

```
program testsieve;          {     Prime Number Sieve Program }
     {     Mike Bentley  3/10/84       }

const
     size = 8190;

var
     j, niter, ncount:    integer;
     ch: char;

     function sieve: integer;
     var
          i, prime, k, count:      integer;
          flags:                   array [ 0 .. size ] of boolean;

     begin
          count := 0;
          for i := 0 to size do
               flags[ i ] := true;
          for i := 0 to size do begin
               if ( flags[ i ] ) then begin
                    prime := i + i + 3;
                    k := i + prime;
                    while ( k <= size ) do begin
                         flags[ k ] := false;
                         k := k + prime;
                    end;
                    count := count + 1
               end
          end;
          sieve := count
     end; { sieve }

begin
     writeln; write(' Number of Iterations:');
     readln(niter);

     writeln; write(' Press (CR) to start:');
     readln(ch);

     for j := 1 to niter do
          ncount := sieve;

     writeln(' Done!')
end.
```



DAVID SCHWADERER

In an excerpt from his forthcoming book, the author uncovers the mysteries of modems

Modems DEMYSTIFIED

To most PC users a modem is simply a small magical device that enables a computer in one part of the world to carry on a telephone conversation with one in another part of the world. Some users may understand that the modem serves as an intermediary, translating digital data into sounds that the telephone system can carry. Beyond this, however, the concept of how a modem works remains a mystery to all but a small percentage of computer operators. But, obviously, that little box conceals a complex process through which information is translated, sent, and received from one computer to another regardless of geographic limitations.

Modems can be divided into a variety of categories: half duplex or full duplex, acoustic coupled or direct connect, originate and answer modes, and manual or auto-dial/auto-answer. This article discusses only full duplex modems (unless otherwise noted) because most PC communication programming is done for either full duplex communication sessions or for half duplex

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communication sessions that are software enforced on a full duplex connection. In both instances, a full duplex modem is used.

Acoustic coupled modems are used by placing a telephone handset into a set of rubber cups (or grommets) on the modem after the call has been manually dialed. The data tones pass right through the telephone just as a voice would. This type of modem generates/receives actual physical acoustic waves (sounds) for/from an ordinary telephone (not the telephone line, but an actual telephone). Therefore, it is sensitive to extraneous noise and vibrations around the PC. Because of this sensitivity and the increasing number of telephone handsets that do not fit the grommets, these modems are rapidly becoming outdated. In its day, however, the acoustic modem was a blessing. It was the only way to get around Bell Telephone's monopoly and was instrumental in ending the monopoly.

Some modems provide/receive data tones directly to/from the telephone line jack and completely bypass the telephone handset. These direct-connect modems do not require a set of rubber cups. (This type of modem is to be distinguished from an old-fashioned type called a data access arrangement (DAA) modem that required protective—and expensive—Bell Telephone devices between it and the telephone line.) With a direct-connect modem a telephone may still be used to dial the remote system, but, once the connection has been made, operators manually flip a switch, push a button, or pull a knob causing the telephone to step aside as the data flow directly to/from the modem from/to the line. In general, a direct-connect modem is superior to an acoustic modem.

When a PC user calls a remote system for a data communication session, he is the originator of the telephone call. Therefore, the modem should assume the originate mode during the communication session unless prior arrangements have been made. Likewise, the party or system that answers the phone should assume the answer mode.

Thus, there are two modem operating modes—answer and originate. Some modems can operate in both modes, although in only one at a time. However, some modems can operate in one mode but never in the other. If the latter is the case, then the other communication modem must adapt to the design of its partner (that is, it must operate in the second mode) or no transmission of data can occur. In general, modems that have both originate and answer capability should be used.

Some modems require users to answer/dial the remote system manually and either flip switches, pull knobs, or push buttons to establish the connection. That's fun for the first 100 or so times. Later on and in the wee hours of the morning it is a nuisance. Therefore, numerous modems have the capability of automatically dialing and/or answering the telephone. The modem signals the PC that it has already contacted the remote system, and the telephone number is sent by the PC for transmission on the nonexistent telephone line. The modem traps the data, dials the number, and gets out of the way of the PC's transmission data when the connection is made.

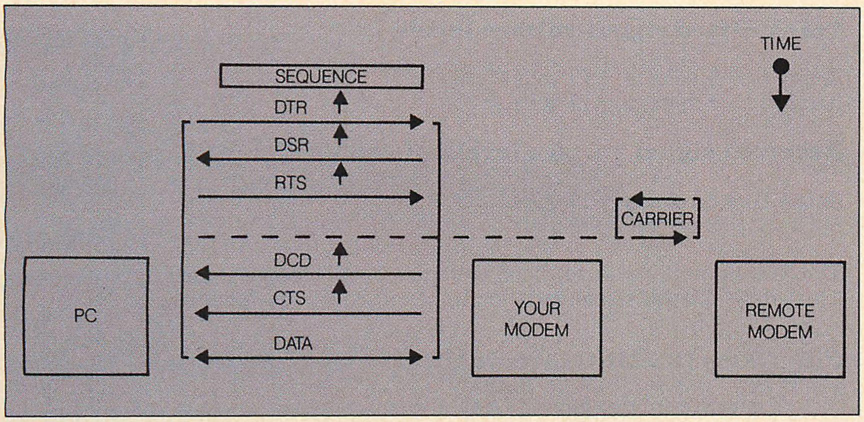
In communication programming, a PC usually will act like a terminal, though with a little effort it can also look like a remote system to another PC. Since the PC acts like a terminal, it is referred to as the *data terminal equipment* (DTE). Actually, both the PC and the remote system are always referred to as the DTE even though the remote system may be a large central mainframe computer. The modem is referred to as the *data communication equipment* (DCE) or *data set*, terms that can be used interchangeably. The DTE is connected to the DCE via a special line called the modem cable. The cable has multiple wires and is the vehicle by which the DTE (here, the PC) sends/receives digital signals to/from the DCE or data set (modem).

THE RECOMMENDED STANDARD

One popular way to use this cable is known as the RS-232-C (for Recommended Standard 232 Version C). The real name of this standard is "Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Exchange." It was adopted by the Electronic Industries Association (EIA) in August 1969, and it specifies how to get data from the PC communications adapter to the modem, and vice versa, in a standard way. The standard allows a PC to be connected to many different manufacturers' modems and specifically indicates that the cable connection may use as many as 25 wires, with each wire present performing a specific function in a specific way. Note that the standard does not specify which wires have to be present. It simply states that if, for example, wire two is present, then it *must* be used to carry the data bit stream from the DTE (PC) to the DCE (modem). The wire cannot be used in any other way.

There the problems begin. Many modems use some wires, but not others. Moreover, the PC requires its own specific set of wires and modem signals to operate without sleight of hand. A modem may adhere to the RS-232-C standard but not work with the PC. Simply stated, like the PC, a modem is said to adhere to the standard if it does not violate that standard. Partial implementation of the standard by a given modem is not considered a violation; different partial implementations, however, cause different modems to require different cables to operate correctly. The trick is to know which wires are required

Figure 1: Modem Signal State Diagrams



by the PC *and* a given modem. Unfortunately, even that isn't always good enough, despite the good intentions of some manufacturers.

Note that the specification does not state how the 25 wires are connected to the DTE and the DCE. Various connectors are available, but the most commonly used type is known as a Subminiature Type D connector (DB-25). In short, one pin in one connector is normally connected to one pin in the other connector. In addition, note that the PC requires a female connector (DB-25-S), and most modems require a male connector (DB-25-P). It is a good idea to buy the communications adapter and modem before buying the modem cable.

The EIA RS-232-C standard specifies the voltage levels allowed on the wires and the meaning and direction of the signal. For example, a voltage level of +5 to +15 volts on pin 2 indicates that the DTE is transmitting a binary 0 to the DCE, while a voltage level of −15 to −5 volts on pin 2 indicates that the DTE is transmitting a binary 1 to the DCE. A voltage level of −5 volts to +5 volts on pin 2 has no meaning and is said to be in the transition zone.

Before any data are transmitted to the remote system, a few very important signals must be passed back and forth between the PC and the modem. First, the PC, or DTE, signals the modem on pin 20 that it is ready. This signal is called *data terminal ready* or DTR. Similarly, when the modem is ready, it signals the PC on pin 6 that the data set is ready. This signal is called *data set ready*, or DSR. Strictly speaking, these signals should occur in the above sequence, although they often do not for a variety of reasons. If they have not occurred by this point, then the prescribed receiver of a missing signal should be configured so that it does not require the signal. See figure 1.

Next, the PC signals on pin 4 that it wants to send data. This signal is referred to as *request to send* (RTS). However, because communications have not yet begun, the modem does not acknowledge the request. Hence, it is by default denied, unless the modem knows it should obtain a telephone number from the PC for remote system dialing. When contact is made, the remote system's modem sends out a short tone blast of approximately 2,000 Hz to disable the echo suppressors on the telephone line and then emits a recognizable tone called an answer modem carrier. This allows the modem to recognize it has reached an acceptable answer modem (as opposed to an originate or otherwise unacceptable modem).

At this point, the sending modem signals the remote modem that it is a valid originate modem via an originate modem carrier and tells the PC on pin 8 that it has detected a valid answer modem carrier. This modem-to-PC signal is referred to as *data carrier detect* (DCD), *carrier detect* (CD or CXR), or *received line signal detector* (RLSD). After each modem is satisfied that the other modem is ready to receive, the modems signal their respective DTEs that the path is clear to send data.

This signal occurs on pin 5 and is called *clear to send* (CTS). In half duplex communication, the CTS signal is the acknowledgment to a PC's outstanding RTS and allows the PC to begin transmitting data. In full duplex communication, the signal normally remains present after this point, and the signal is no longer required.

When the PC wants to send data, the communications adapter presents the data to the modem one bit at a time on pin 2. When the PC receives data, the communications adapter receives it one bit at a time on pin 3. The PC communications adapter groups the individual data bits into characters for the PC and delivers them to BASIC.

The RS-232-C standard is summarized in figure 2. The important modem signals for the PC are on pins 1 through 8 and pin 20.

On the front panels of many modems there are indicator lights that reflect specific signal states. These lights are essential in problem determination efforts and are useful to watch as the data roll in and out of the PC. A modem that does not have such indicator lights may use a device called a break-out box, which is connected between a PC and a modem and provides the equivalent of a modem front panel. Break-out boxes, however, often have prices in excess of $100.

If a modem is going to be used as an auto-answer modem, then the PC may need to know when someone is calling its telephone number. Thus, a telephone ring indicator (RI) signal is provided to the PC by the modem on pin 22. An auto-answer modem will answer a call

immediately after a ring is complete, but only if the PC is indicating that it is ready to receive the call via the DTR signal on pin 20.

MISSING MODEM SIGNALS

Many popular modems do not normally provide the full complement of signals to the PC. There are five approaches to fixing this problem. The first is simply to ignore the missing signals in the programming and/or program execution and just press on. This can be disadvantageous for a number of reasons: the modem might be broken, not connected to the PC, or, perhaps, not even plugged into a telephone or electrical outlet. This approach also may fail because the user is not able to modify the PC program.

A second approach is to adjust the option settings that may be on the modem, forcing it to provide the required signals. These settings, referred to as strapping options, assume a variety of forms (switches, buttons, etc.). Since many modems can use strapping options to ignore the absence of required signals from the PC, these options make such modems "forgiving" and flexible.

The third solution to the problem of missing signals is to purchase a "smart cable" that detects when a signal is missing and automatically provides it. Such cables are advertised in popular computer journals. Because these cables have only recently become available, not much can be said about them except that they exist. The reviews are promising, although the suggested price is approximately $90 per cable.

A fourth and very common approach is to jump (short-circuit, strap, or cross-wire) various connector pins with pins that already have the correct values. This approach has the advantage of making the PC relatively independent of the modem being used without having to change any PC programs. Assuming only full duplex modems are being used, clear to send (CTS), data

Figure 2: RS-232-C Summary

Transmitted signal voltage levels:

Binary 0: +5 volts to +15 volts
Binary 1: −5 volts to −15 volts

Received signal voltage levels:

Binary 0: +3 volts to +15 volts
Binary 1: −3 volts to −15 volts

The Transition (Undefined) Zone is from −3 volts to +3 volts.
This allows a 2-volt signal variation between sender and receiver.

Pin	Name [RS-232-C Circuit ID]	Direction
1	Protective (frame) ground [AA]	N/A
2	Transmitted data [BA]	DTE ——→ DCE
3	Received data [BB]	DTE ←—— DCE
4	Request to send [CA]	DTE ——→ DCE
5	Clear to send [CB]	DTE ←—— DCE
6	Data set ready [CC]	DTE ←—— DCE
7	Signal ground [AB]	N/A
8	Received line signal detect [CF]	DTE ←—— DCE
9	Positive DC test voltage	N/A
10	Negative DC test voltage	N/A
11	Unassigned	N/A
12	Secondary data carrier detect [SCF]	DTE ←—— DCE
13	Secondary clear to send [SCB]	DTE ←—— DCE
14	Secondary transmitted data [SBA]	DTE ——→ DCE
15	Transmitter signal element timing [DB]	DTE ←—— DCE
16	Secondary received data [SBB]	DTE ←—— DCE
17	Receiver signal element timing [DD]	DTE ←—— DCE
18	Unassigned	N/A
19	Secondary request to send [SCA]	DTE ——→ DCE
20	Data terminal ready [CD]	DTE ——→ DCE
21	Signal quality detect [CG]	DTE ←—— DCE
22	Ring indicator [CE]	DTE ←—— DCE
23	Data signal rate selector [CH/CI]	Varies
24	Transmit signal element timing [DA]	DTE ——→ DCE
25	Unassigned	N/A

Here, the DTE is the PC and the DCE is the modem. A given signal wire need not be present for the connection to conform to the standard. For more information, contact:
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Engineering Department
2001 Eye Street N.W.
Washington D.C. 20006

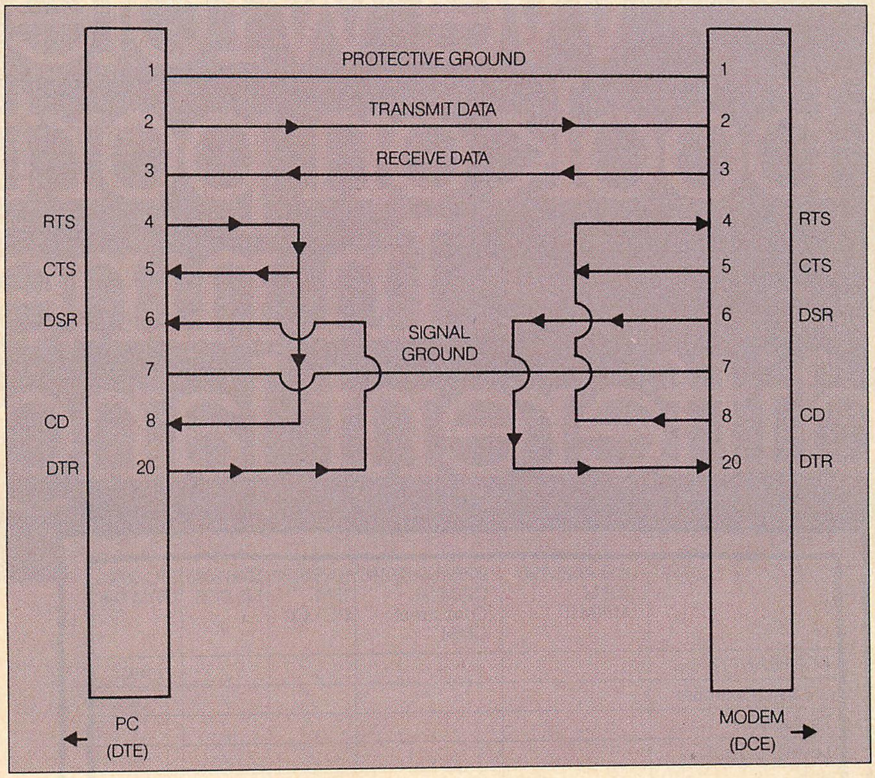
set ready (DSR), request to send (RTS), carrier detect (CD), and data terminal ready (DTR) should normally be present unless the session is experiencing errors or is starting or ending. Thus, if these signals are missing and/or are not available to either the modem or PC, a "cheater cable," shown in figure 3, can be fabricated that will make the missing signals appear.

If DTR is signaled, or asserted, by the PC, and if DSR is not provided by the modem, a wire from the PC's DSR pin can be soldered to the DTR pin, and the problem is solved. (All soldering is done on the cable, not the PC.) Then, when DTR is asserted by the PC, DSR is instantly received by the PC. Similarly, a wire can be run from the RTS pin to the CTS and/or CXR pin so that CTS and/or CXR appear to the PC as soon as RTS is asserted by the PC. Finally, if DTR and RTS are not provided to the modem by the PC, a wire from the DSR pin can be soldered to the DTR and from the CTS pin to the RTS pin of the modem cable. After this is done, DTR appears to the modem as soon as the DSR signal is asserted by the modem, as does the RTS signal when CTS is asserted.

Although the PC may at times sense incorrect and/or misleading signals, in some cases these signals may never occur in any form unless the user resorts to these methods. Additionally, one provision of the RS-232-C standard states that any wire can be safely shorted with any other wire and no electrical damage should occur anywhere. The soldering solution is an unpleasant approach that may be necessary to get some modems to work with the PC. Soldering should be performed only by an experienced individual.

The fifth and final approach to the missing signal problem is to use a patch box. This device solves the jumpering problem without soldering pin jumper wires. Although it has the advantage of avoiding any soldering and making the PC relatively independent of any modem connection, this approach may require a second modem cable.

Figure 3: Cheater Cable



One last suggestion while the soldering iron still is hot: a null modem or modem eliminator cable, which allows two PCs to be directly connected together without modems, can be made using approach three or four discussed above. One important point to remember is that wires two and three should be reversed on one side of the cable. This is required because each PC would otherwise try to transmit on pin 2 and listen on pin 3 for incoming data. Reversing these wires on one side of the cable causes the data to arrive correctly at each end.

Using such a cable allows two PCs to transfer disk files using the PC DOS COPY command. If the cable were short enough, the transfer could be performed at 9,600 BPS, the maximum speed that can be specified by the PC DOS MODE command (used to initialize the asynchronous communications adapter for use by the COPY command). The length of the cable is important because electrical engineering theory states the length of a cable determines the maximum speed of data transfer on it. The RS-232-C standard specifies that a 50-foot RS-232-C cable should handle up to a 19,200-BPS transfer rate. Since most cables are less than 10 feet long, they can transfer data at 9,600 BPS with no problem.

Two modems signal their presence to each other via carrier tones. One must be an answer modem carrier that is presented by a modem in answer mode. The other must be an originate modem carrier presented by a modem in originate mode. The carriers are different, and each modem looks for a carrier that is different than the one it is presenting on the telephone line.

Types of Modems

The carrier tones have specified frequencies that depend on the type of modem being used. Three modem types are prevalent. Other modems

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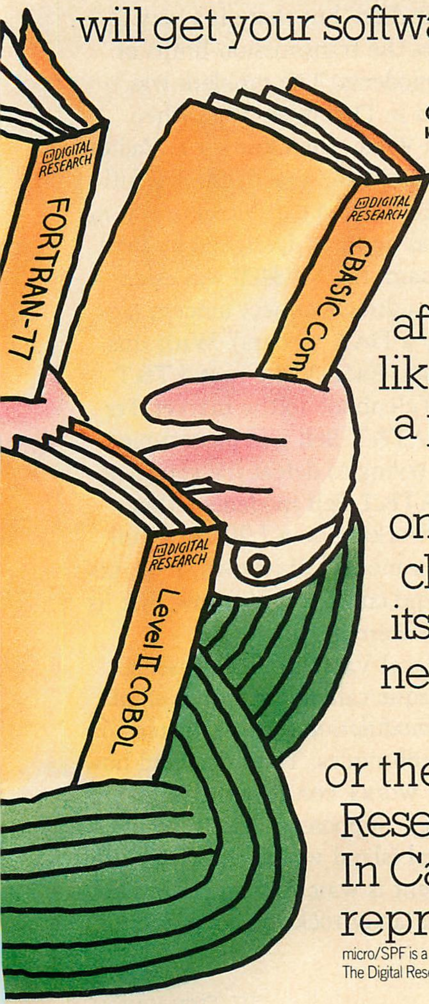

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are similar, but different enough that they will not work with the three prevalent types.

The AT&T Bell 103 modem is used for speeds of zero to 300 BPS. It uses a simple transmission technique known as *frequency shift keying* (FSK). In this scheme the originate modem transmits a 1,270-Hz tone for a binary 1 (MARK) bit and a 1,070-Hz tone for a binary 0 (SPACE) bit. Similarly, the answer modem transmits a 2,225-Hz tone for a binary 1 (MARK) bit and a 2,025-Hz tone for a binary 0 (SPACE) bit. Since each modem has its own set of transmit frequencies, both modems can transmit and receive simultaneously. The transmitted tones are the modems' carrier signals. They are said to be modulated by the transmitter and demodulated (converted back to binary data) by the receiver.

Understanding the AT&T Bell 103 frequency shift keying (FSK) technique is easy; however, using the technique to send/receive at faster rates leads to problems. Transmission theory textbooks state that FSK needs a signal of about 1.5 Hz to send one bit per second in a given direction over a telephone line. The AT&T Bell 103 sends 300 BPS one way and 300 BPS the other way. That's a total flow of 600 BPS, and since 1.5 × 600 equals 900, the AT&T Bell 103 modem requires a 900-Hz capability.

The usual telephone circuit can transmit tones between 300 and 3,300 Hz; 3,300 minus 300 leaves a total of 3,000 Hz (called 3,000 Hz bandwidth) that is available for transmission. (Actually, some frequencies located in the range of 2,450 Hz to 2,750 Hz, called tandem tones, are reserved by the telephone company. It is not advisable to program a PC to emit tones within the reserved frequency range on a PC speaker near a telephone.) Since 900 Hz is less than 3,000 Hz, the AT&T Bell 103 modem works just fine on a telephone line.

How about 1,200 BPS? Using FSK to transmit at 1,200 BPS in a full duplex mode will require the ability to handle 2,400 BPS (1,200 BPS each way). This requires 3,600 Hz worth of bandwidth signals that do not fit within the available 3,000-Hz bandwidth. Since only 3,000 Hz are available, FSK can actually handle only 2,000 BPS total (3,000 divided by 1.5). This gives rise to a variety of methods for using the available transmission capability of a telephone line.

Some modems divide the transmission power unevenly. For example, the AT&T Bell 202 modem provides 1,200 BPS in one direction and an optional 5 BPS in the backward, or reverse, channel. The high-speed direction is referred to as the primary channel. This reverse channel approach allows high-speed transmission in one direction using inexpensive FSK circuitry (a 1,200-Hz tone signals a binary 1 and a 2,200-Hz tone signals a binary 0) and is used when a disproportionate amount of information needs to be shipped in one direction.

The reverse channel can be used to acknowledge successful receipt of large data blocks arriving on the primary high-speed channel without the penalty of a line turnaround. (Half duplex sessions conducted without such a reverse channel are sometimes referred to as "send and pray" sessions.) It is implemented by transmitting a tone of 387 Hz to signal a binary 1 and removing the tone to signal a binary 0. This type of signaling is called *on-off keying* (OOK) because the signal is either present or absent. On-off keying is useful only in slow communication speeds (less than 5 BPS) and is an extreme version of a more general form of modulation that is known as *amplitude modulation* (AM). In amplitude modulation, the tone has one amplitude (volume or strength) when transmitting a binary 1 bit and another when transmitting a binary 0 bit.

Since the reverse channel on a Bell 202 modem can transmit at only 5 BPS, what happens if both communicating machines have a lot of data to transmit? Is one forced forever to transmit at 1/240th the speed of the other? Not really; the AT&T Bell 202, operating on a two-wire connection, also is a half duplex modem in its own right, and the communicating systems can reverse the line (both the primary and reverse channel are able to change directions) to share the bandwidth. Thus, another way to solve the problem of FSK high-speed transmission is simply to use FSK on half duplex modems. This allows each side to own a maximum 2,000-BPS path from time to time at the expense of line turnarounds. Note that the PC communications adapter cannot handle reverse channel. Once again, try to avoid half duplex modems.

FSK really cannot get the job done for 1,200-BPS full duplex communication, but there is a way to bypass the transmission limits of FSK modems. The problem was solved in December 1972 when Racal-Vadic (then known as Vadic) introduced the first 1,200-BPS full duplex modem capable of operating on dial-up lines. Designed by John Bingham, the VA3400 was essentially a direct-connect modem (actually a DAA modem). With this product, Racal-Vadic beat AT&T Bell Telephone to the market. Perhaps AT&T Bell was preoccupied with trying to defeat the spread of non-AT&T Bell modems rather than working on a 1,200-BPS, full duplex modem of its own. If so, history and court records show that its efforts were in vain.

Racal-Vadic's modem used a technique called *quadrature amplitude modulation* (QAM), instead of FSK techniques. To understand how QAM works, consider the following analogy. Suppose you visit a quiet, tropical island where the major excitement is watching an ocean buoy as you lazily rock for hours in a


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shaded hammock. Each time you tip toward the blue sea, the buoy can be seen riding the distant choppy waves. The waves are arriving, say, *exactly* four times faster than your hammock rocks. The buoy is always in the exact trough (bottom) of an arriving wave. Suddenly, you look as always, and the buoy is now (and subsequently) positioned at the top of an oncoming wave.

Over time, you keep records of the position of the buoy with respect to the oncoming waves, and the buoy is always in one of four positions. It is in the trough, halfway up the face of a wave, at the top of a wave, or halfway down the back of a wave. Curiously, but consistently, each position marks either ¼, 2/4, ¾, or 4/4 (1) of the cycle of a wave. After careful checking you determine that neither the buoy nor the speed of your rocking changes. In addition, the waves are not any higher or lower; neither are they traveling faster or slower. The waves themselves seem constant.

Clearly what is changing is the arrival pattern of the waves. For whatever reason, the sets of waves seem to jump suddenly forward or backward a bit, perhaps due to the force of some distant storm. Technically, their phase is changing, causing them to appear ahead or behind the position in which you next expect them to be.

The VA3400 modem's QAM applies a similar notion to achieve data transmission. As before, one modem on the line is in answer mode, and the other modem is in originate mode. The modem in originate mode transmits a constant signal of 2,250 Hz. The modem in answer mode transmits a constant signal of 1,150 Hz. (Contrast this to the FSK technique in which each modem uses two frequencies.) Each modem "floats an electronic buoy" on the incoming sound waves transmitted by the other modem. Periodically, each modem checks where its buoy is in relation to the oncoming waves and interprets the position as data that are immediately passed to the PC. The buoy could be in four possible positions.

Figure 4: Wave Buoy/Racal-Vadic QAM Positions

POSITION ON WAVE	POSITION NUMBER	BINARY VALUE	WAVE CYCLE COMPLETION	DEGREE PHASE SHIFT
½ Up Face	0	00	25%	90 Degrees
½ Down Back	1	01	75%	270 Degrees
Trough	2	10	0%	0 Degrees
Top	3	11	50%	180 Degrees

As shown in figure 4, the data that are sent to the PC by the QAM modem are the binary values of the position numbers. The column entitled Wave Cycle Completion indicates how much of the wave has passed underneath the buoy when it is in its indicated position. (In trigonometry, the sine function is also called a sine wave when graphed because it has the shape of a wave.) The last column reflects the angular difference between the buoy's position as indicated in the first column and its expected position. In short, these phase shift values are relative to the last buoy observation and change as the buoy makes different appearances on the waves.

Note that each positioning of the buoy corresponds to two transmitted bits. Two such paired bits are called a dibit. Thus, if a PC is transmitting at 1,200 BPS, the remote system's modem will receive 600 dibits per second with each dibit containing two bits. Hence, QAM is correctly described as being a dibit encoded phase shift keying form of modulation. QAM is sometimes mistakenly referred to as *dibit phase shift keying* or, worse, *differential phase shift keying*.

A fleeting four years after the introduction of the VA3400, AT&T responded to the exploding market for 1,200-BPS, full duplex, switched modems with a full duplex 1,200-BPS, direct-connect modem of its own, the Bell 212A. This modem also used a variation of phase shift modulation, called *four phase differential phase shift keying* (or *four level differential phase shift keying*), that was totally incompatible with the VA3400's QAM.

The incompatibility arises from a number of 212A design points. First, Bell 212A changed the phase shifts for some of the dibit pairs. More importantly, Bell altered the carrier frequencies that the VA3400 used for the originate and answer modes. The Bell 212A modem operating in originate mode transmits a phase-shifted signal of 1,200 Hz, and it transmits a phase-shifted signal of 2,400 Hz in answer mode.

Notice that the originate frequency is exactly twice the answer frequency. This selection of frequencies aggravates a problem at the originate end known as *second harmonic interference*, which is caused by the carbon microphone in a telephone's handset. The effect is an echoing of transmitted signals that can make arriving data tones indistinguishable from the echoes.

In addition, selection of these frequencies is apparently causing other problems now. Recent evidence indicates that the Bell 212A may have unpredictable problems on General Telephone and Electric's Sprint long-distance system. This is because the tandem tone of 2,000 Hz mentioned earlier is unpredictably stripped from telephone traffic on the Sprint system. In doing this, Sprint also removes some of the signal strength in surrounding frequencies, namely the 2,400-Hz Bell 212A answer mode frequency.

It would be helpful if the Bell 212A modem signal receivers were

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the best possible. But apparently even today, this modem has a receiver that is less sensitive than that of the 10-year-old Racal-Vadic 3400, which enables the 3400 to function better on the poor quality phone lines in many areas of the world. Compounding the problem, the 212A uses a scrambler in its receive and transmit circuitry that has the potential to cause arriving character-receive errors to propagate as errors in characters arriving later.

A variety of non-Bell modems now available are Bell 212A compatible and provide many new functions in addition to standard 212A functions. Racal-Vadic took less than a year to introduce a "triple mode" modem that combined the features of the 103, 212A, and VA3400 modems. The Bell 212A's operating characteristics now are the predominant standard in 1,200-BPS personal computer modems, and this modem has eclipsed competitive modems that had superior features. Figure 5 summarizes the features of Bell 103, 202, 212A, and Racal-Vadic 3400 modems.

We have seen that modems modulate their carrier signals in three ways: amplitude modulation (AM), which includes on-off keying (OOK); frequency shift keying (FSK); and phase shift keying (PSK). (See figure 6, AM/FSK/PSK.) We also have seen that the Bell 202 modem uses both FSK and (on the optional reverse channel) a form of AM called OOK. Some half duplex modems go a step further and mix AM with PSK to achieve 9,600 BPS on a leased line. *Phase amplitude modulation* (PAM) is such a mix. One PAM scheme uses 12 phase shifts and employs "bigger waves" on four of the phase shifts to identify 16 unique signal states. Thus, each signal communicates four bits. The modem circuitry to do this is complex. In addition, there is a finite limit to the number of unique phase shifts that can be used in a modulation scheme because the telephone system has noise (chop on waves) that makes increasingly subtle phase shifts indistinguishable from line noise.

In addition to the RS-232-C interface previously discussed, there is a current loop interface for the PC's communications adapter. This interface

Figure 5: Modem Theory Summary

The Bell 103
Full duplex
Speed: 0-300 BPS
Modulation method: Frequency shift keyed

		Transmit Frequency	Receive Frequency
Originate mode:	MARK = 1	1270 Hz	2225 Hz
	SPACE = 0	1070 Hz	2025 Hz

		Transmit Frequency	Receive Frequency
Answer mode:	MARK = 1	2225 Hz	1270 Hz
	SPACE = 0	2025 Hz	1070 Hz

The Bell 202
Half duplex on switched (dial) line, full duplex on four wire
Leased line speed: 0-1200 BPS on switched (dial) lines,
0-1800 BPS on leased lines
Modulation method: Frequency shift keyed

	Transmit Frequency	Receive Frequency
MARK = 1	1200 Hz	1200 Hz
SPACE = 0	2200 Hz	2200 Hz

Optional 5 BPS on-off-keyed reverse channel at 387 Hz

The Bell 212A
Full duplex with integrated Bell 103 modem for slow speed transmission
Speed: 1200 BPS
Modulation method: Phase shift keyed for 1200-BPS transmission

	1200 BPS Transmit Frequency	1200 BPS Receive Frequency
Originate end	1200 Hz	2400 Hz
Answer end	2400 Hz	1200 Hz

Phase shifts:
0 Degrees ⟶ Dibit = 01
90 Degrees ⟶ Dibit = 00
180 Degrees ⟶ Dibit = 10
270 Degrees ⟶ Dibit = 11

The Racal Vadic 3400
Full duplex with integrated Bell 103 modem for slow speed transmission
Speed: 1200 BPS
Modulation method: Phase shift keyed for 1200-BPS transmission

	1200 BPS Transmit Frequency	1200 BPS Receive Frequency
Originate end	2250 Hz	1150 Hz
Answer end	1150 Hz	2250 Hz

Phase shifts:
0 Degrees ⟶ Dibit = 10
90 Degrees ⟶ Dibit = 00
180 Degrees ⟶ Dibit = 11
270 Degrees ⟶ Dibit = 01

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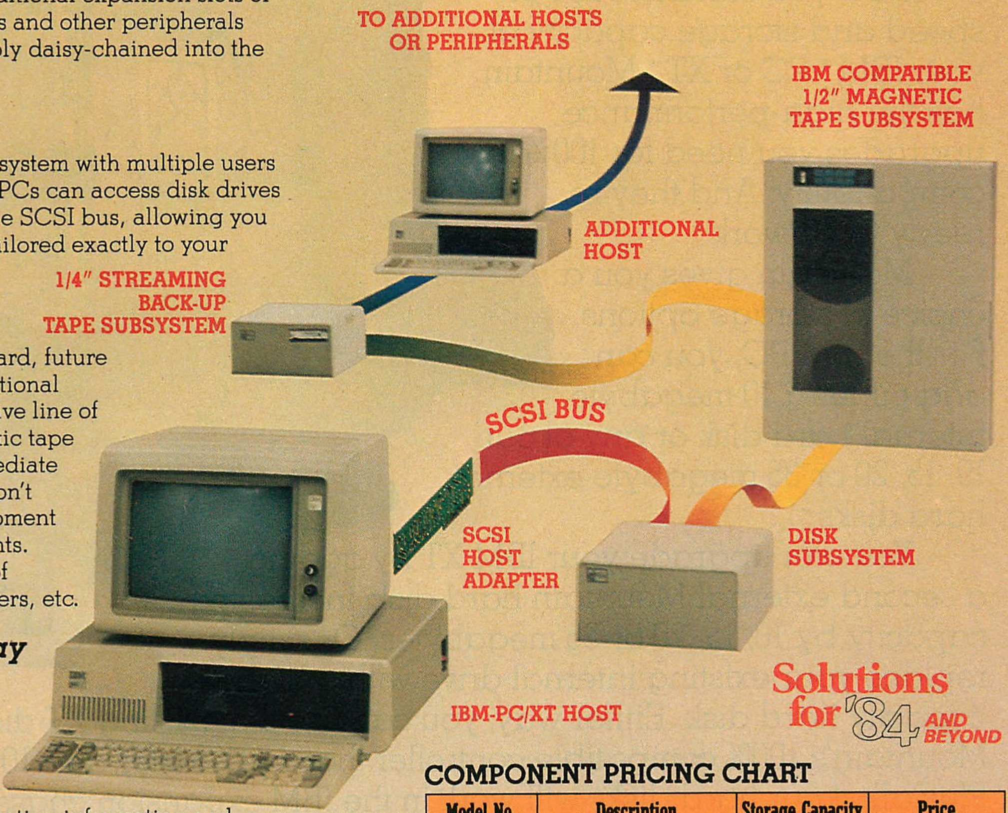

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RD 2035M	Master Disk Subsystem	35MB	2950.00
RD 2047M	Master Disk Subsystem	47MB	3150.00
RD 2126M	Master Disk Subsystem	126MB	6840.00
RD 2011S	Slave Disk Drive	11MB	1560.00
RD 2023S	Slave Disk Drive	23MB	2130.00
RD 2035S	Slave Disk Drive	35MB	2530.00
RD 2047S	Slave Disk Drive	47MB	2730.00
RD 2126S	Slave Disk Drive	126MB	6290.00
RD 8111H/A	IBM-PC/XT Host Adaptor		510.00
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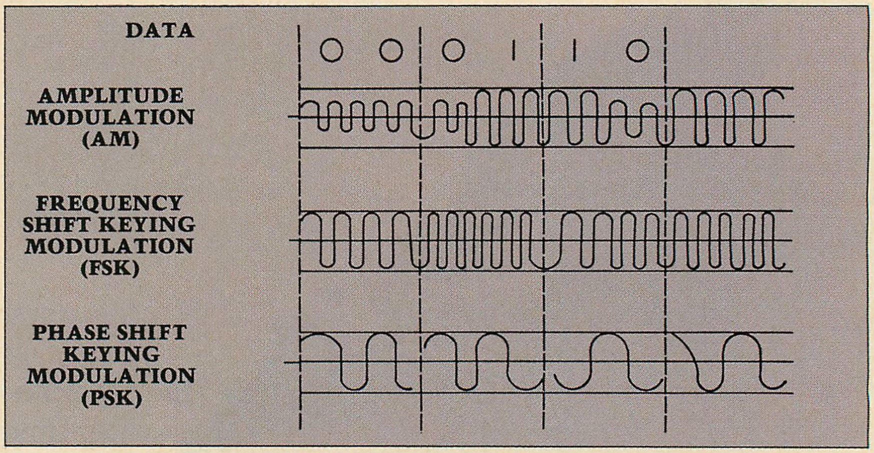
has two variations: the 20-milliampere and the 60-milliampere current loop interfaces. The PC supports only the 20-milliampere version. This connection method is used by the popular model 33 Teletype that was introduced in the early 1960s and still is popular in numerous computing facilities. It can be very inexpensive to use and allows devices to be located up to 30 times farther (1,500 feet) away from the PC than the RS-232-C interface allows (50 feet). However, this type of connection is prone to noise and does not have a standard that compares to the EIA RS-232-C standard.

Two points must be remembered about the current loop type of connection. First, it exists. Second, in order to use it, the PC's asynchronous communications adapter must be removed from the system unit and a jumper block must be reversed on the communications adapter card. For further details see the section in the PC *Technical Reference* manual entitled "Asynchronous Communications Adapter" and review especially the material under the topic entitled "Interface Description." Warning: Be sure to review and understand this material fully *before* attempting to use the current loop interface. Otherwise, some of the computer's circuits could be burned out.

Besides bits per second, transmission speed can be measured in baud. This is the rate at which the communicating modems individually signal one another. If the modems are using the frequency shift keyed technique, as does the Bell 103 modem, then transmission BPS rate will be the same as the modems' baud rate. However, if four phase differential phase keying is being used, the BPS rate will be double the baud rate. In general, the baud rate and BPS are not identical and, therefore, should not be interchanged freely. Specifically, the baud rate of a BELL 212A modem is 600 baud, which transfers data at a rate of 1,200 BPS using four phase differential phase shift keying.

Figure 6: AM/FSK/PSK



BUYING A MODEM

Below is a summary of important modem features to review before making the decision to buy a particular type of modem.

1. FCC Approved—allows legal direct connection of a modem to a telephone jack and avoids the use of an intermediate device called a data access arrangement, or DAA. A user is required by law to notify the telephone company that he plans to connect a modem to a phone line. The telephone company may then surcharge a customer $50 per month for a "data grade" line. This is curious because: (1) The customer still will be using the original "voice grade" telephone line; (2) He will have never requested a "data grade" telephone line; and (3) Modems are designed to work on "voice grade" telephone lines.

2. Full duplex

3. Direct connect

4. Originate/answer modes

5. 0 to 300 BPS mode—AT&T Bell 103 Compatible

6. 1,200 BPS mode—AT&T Bell 212A Compatible (Avoid AT&T Bell 202 type modems. The 202 is a 1,200-BPS modem that operates in half duplex mode only. It is less expensive but much less useful than a 212A.)

7. External vs. integrated (on a PC adapter card)

8. Front panel signal indicators (if external)

9. Intelligent (but easy)

10. Audo-dial with rotary and Touch Tone dialing

11. Auto-answer

12. Auto-speed Select (dynamically senses correct BPS rate)

13. Call-in-progress capability (dial tone detect, number busy, voice vs. modem answer, etc.)

14. Error diagnostic capability

15. Strapping options

Many of these features can be found in a modem costing approximately $200. The higher-speed 1,200-BPS capability can be included for a total price of less than $500. Call-in-progress features cost more.

Three modems that have many of the above features are Racal-Vadic's VA212PA, Hayes Microcomputer Products' Smartmodem 1200, and Novation's 103/212 Smart-Cat. The names of the specific modems are trademarks of their respective manufacturers.

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This design elegance leads naturally to more elegant performance. Take line status detection, for example. The PC:IntelliModem's adaptive, decision-directed logic monitors line status more closely than other modems. Even at weak or degraded signal levels. So it can make connections with less chance of error, by detecting signals for dial tone, remote ringback, busy and voice–some of which other modems ignore.

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So if you're designing microcomputer datacomm products–or just looking for a PC/XT modem for yourself, check out the PC:IntelliModem at your local dealer. You'll get the message. And so will they. Or contact: Bizcomp, 532 Weddell Drive, Sunnyvale, CA 94089; 408/745-1616.

Bizcomp: A history of innovation.

1980	Invented first command-driven modem
1981	Introduced proprietary line-status monitoring
1983	Designed first single-μP 212A-compatible modem
1983	Introduced first integrated voice/data modem for IBM PC
1983	Granted patent on command-driven modem

Make sure your modem has all these PC:IntelliModem features

Integrated Voice/Data
- Switch between voice and data communications
- Programmable telephone handset jack

Status Reporting
- Line status detection (dial tone, busy, remote ringback, voice answer, modem answer, incoming call)
- Audio monitor
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PC:IntelliCom™ Software Included
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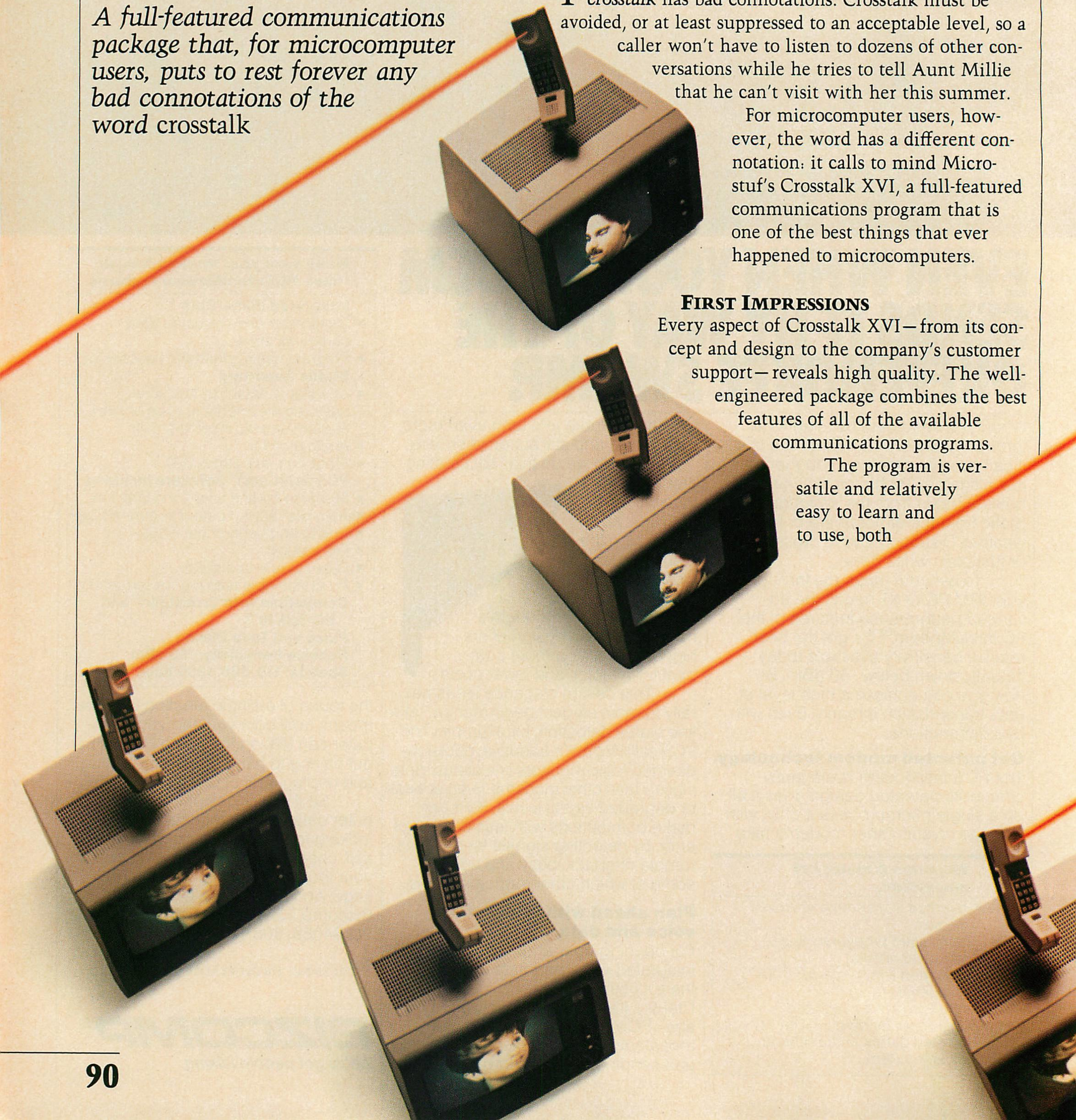
For microcomputer users, however, the word has a different connotation: it calls to mind Microstuf's Crosstalk XVI, a full-featured communications program that is one of the best things that ever happened to microcomputers.

First Impressions

Every aspect of Crosstalk XVI—from its concept and design to the company's customer support—reveals high quality. The well-engineered package combines the best features of all of the available communications programs.

The program is versatile and relatively easy to learn and to use, both

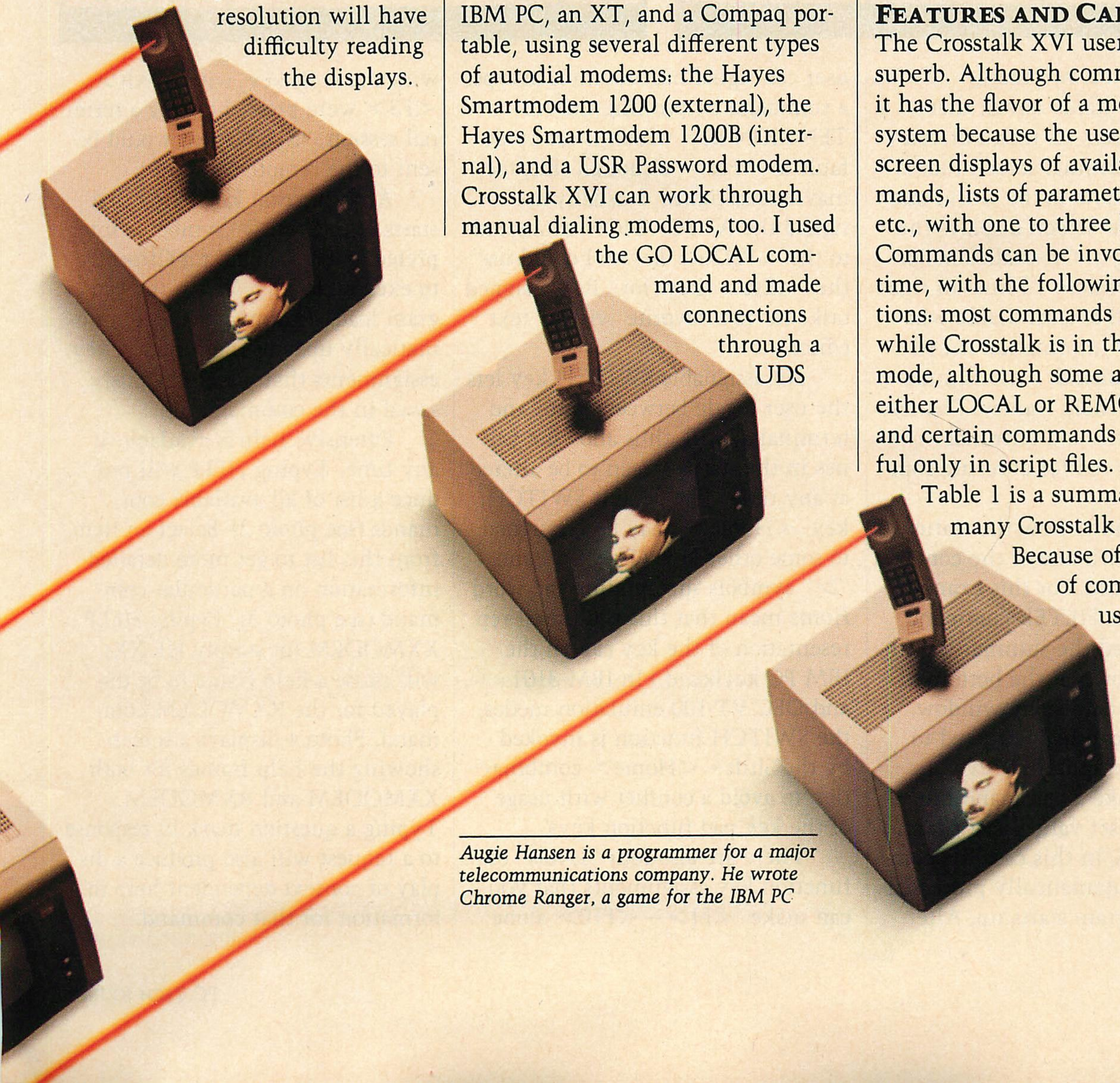


ALKING

for users who prefer command-oriented programs and for those who prefer menu-driven programs. It has such features as data capture to memory and disk and unattended answer operation.

The program is large, requiring a minimum of 96K of main memory to run. Its size is indicative of the range of its capabilities.

If Crosstalk is loaded on a system with a color/graphics adapter, it switches to the 25x80 text mode. Users whose display devices lack resolution will have difficulty reading the displays.



Test Conditions

The program is identified as Crosstalk XVI, version 3.41 for the IBM PC and PC-DOS. The opening frame still says version 3.4; the full version number may be obtained by typing VERSION at the command prompt. Before writing this review, I spent about a month trying unsuccessfully to break the program. The few minor problems I did come across are described in the appropriate places below.

The program was run on an IBM PC, an XT, and a Compaq portable, using several different types of autodial modems: the Hayes Smartmodem 1200 (external), the Hayes Smartmodem 1200B (internal), and a USR Password modem. Crosstalk XVI can work through manual dialing modems, too. I used the GO LOCAL command and made connections through a UDS LP103 modem at 300 baud and through a 212A-compatible at 300 and 1200 baud. Crosstalk ran flawlessly over a 9600-baud, hard-wired connection to a minicomputer.

I communicated with a variety of host systems, including various bulletin boards, The Source, UNIX running on everything from a PC to a large mainframe, and other PCs running Crosstalk in the "answer" mode. Crosstalk proved to be very useful and dependable.

Features and Capabilities

The Crosstalk XVI user interface is superb. Although command driven, it has the flavor of a menu-driven system because the user can call up screen displays of available commands, lists of parameter settings, etc., with one to three keystrokes. Commands can be invoked at any time, with the following restrictions: most commands work only while Crosstalk is in the LOCAL mode, although some are usable in either LOCAL or REMOTE modes, and certain commands are meaningful only in script files.

Table 1 is a summary of the many Crosstalk commands. Because of the number of commands, some users have found the

Augie Hansen is a programmer for a major telecommunications company. He wrote Chrome Ranger, a game for the IBM PC

program more difficult to learn than earlier versions were, but users who are accustomed to command-oriented systems usually take to it quickly. In general, the commands have highly mnemonic names, and using them quickly becomes second nature.

natively, the program can be instructed to load and execute a particular command file. The call parameters can also be set manually in the status screen; Crosstalk will then switch to the terminal screen and try to make a connection.

Once in terminal mode, the

and with <Ctrl>. The FKEY command may be used to set and display the strings of characters associated with each function key. For example, the command "FK S3 My Name" will store the string "My Name" for use with the shifted <F3> key combination. If Shift-

Photo 1: Status Screen Display

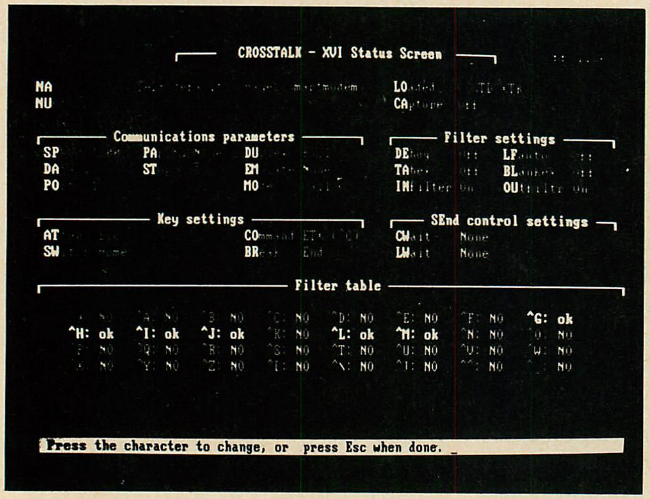
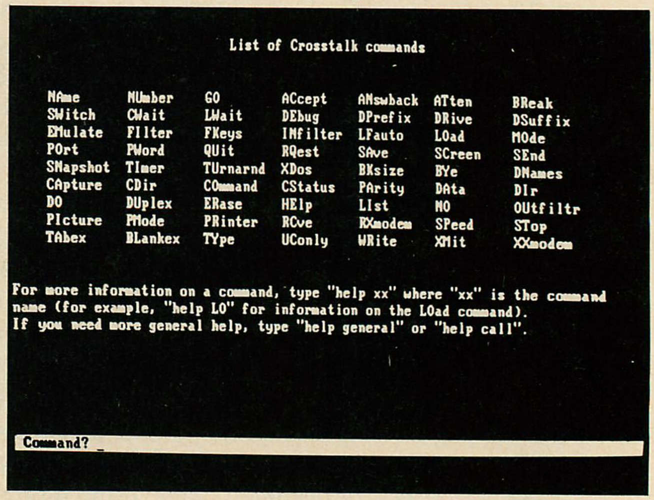


Photo 2: Command Help List



Crosstalk has two main "screens": the status screen that gives the program its menu-driven feel and the terminal screen that is the user's window to the world outside. The status screen displays the current setting of Crosstalk's major options. The bottom 10 lines of this screen are used as a scrollable window to display information called up with a command, such as directory listings or help frames. The last line of the status and terminal screens is reserved for entering commands.

Photo 1 shows how the status screen looks with one of the command files loaded. For this example, I also typed the FILTER command, which produced the summary of filter settings shown at the bottom of the screen in the display window.

Crosstalk can be instructed to call another computer in several ways. It can take a command file containing preset values as a parameter from DOS; in this case the command file is automatically processed when the program starts up. Alter-

user can signal his intention to type a command by pressing the ATTENTION key, which is set by default to <Esc>, although this, too, may be reassigned. I usually assigned the ATTENTION command to the <PgDn> key so I could use the <Esc> key for its assigned task in my favorite visual text editor.

An assignable SWITCH key lets the user toggle between status and terminal at will, thus allowing values in the status screen to be altered at any time. The default SWITCH key, <Home>, may be reassigned to some other key. (The "<" and ">" symbols surrounding the word *Home* mean that this is a literal representation of the key cap on the IBM PC keyboard.) In IBM 3101 and DEC VT-100 emulation modes, the SWITCH function is invoked by the Shift–<Home> combination to avoid a conflict with usage of the key pad function keys.

There are also four "levels" of function key assignments that you can make: <F1>–<F10> alone,

with the shift key, with <Alt>, <F3> were pressed during a terminal session, "My Name" would be sent to the remote computer.

Any function key string that starts with the "@" symbol is interpreted as a command for Crosstalk to execute locally. When the program loads a command file, it automatically updates the function key assignments that were previously saved in the command file.

Extensive help is available at any time. Typing HELP will produce a list of all available commands (see photo 2). Select an item from this list to get more detailed information on a particular command (see photo 3). Typing HELP XXMODEM (or simply HE XX) will cause a help frame to be displayed for the XXMODEM command. Photo 4 displays a screen showing the help frames for both XXMODEM and RXMODEM. Typing a question mark in response to a request will also produce a display of context-dependent help information for that command.

Table 1: Command Summary (Excluding Script Commands). L/R = both LOCAL and REMOTE.

Command	Status	Mode(s)	Description
ACCEPT	New	LOCAL	Control access of callers to files (answer mode operation)
ANSWERBACK	New	LOCAL	Control response to Ctrl-E
ATTENTION		LOCAL	Set key to be used for the ATTENTION command
BKSIZE	NewName	L/R	Set block size for protocol file transfers
BLANKEX	New	L/R	Control "blank expansion"
BREAK	New	LOCAL	Select key used to send the BREAK signal (default = <End>)
BYE		L/R	Disconnect current call but do not return to DOS
CAPTURE		L/R	Control capture and retrocapture functions
CDIR	New	L/R	Check or change current directory (DOS 2.0 only)
COMMAND		LOCAL	Select key to be used by remote callers to indicate that a command follows
CSTATUS	New	L/R	Capture status and search
CWAIT	NewName	LOCAL	Set character wait method for file transfers to slow systems
DATA		LOCAL	Set number of data bits
DEBUG		LOCAL	Set debug mode for display of incoming control codes
DIR		L/R	Formatted directory list, options for size, and transfer time estimates
DNAMES		L/R	Reserve memory for directory manipulations of names
DO	New	LOCAL	Execute a script file
DPREFIX	New	LOCAL	Set dialing prefix for modem
DRIVE	New	L/R	Change default drive or get free space on each drive
DSUFFIX	New	LOCAL	Set dialing suffix string
DUPLEX		L/R	Set full or half duplex
EMULATE	New	LOCAL	Select terminal emulation type
ERASE	New	L/R	Erase files or capture buffer
FILTER	New	LOCAL	View/set in-filter selections
FKEYS	NewName	LOCAL	View/set function key assignments
GO	New	LOCAL	Initiate a communications session
HELP		L/R	Display help frames or list
INFILTER	NewName	LOCAL	Control in-filter operation
LFAUTO		LOCAL	Control auto-linefeed operation
LIST		L/R	List parameter settings
LOAD		LOCAL	List command file names or load a specified command file
LWAIT	NewName	LOCAL	Set line-wait method for file transfers to slow systems
MODE	Revised	LOCAL	Set local system to "call" or "answer" mode
NAME		LOCAL	Set name of called system
NO		LOCAL	(used internally for closing automatic file transfers)
NUMBER		LOCAL	Set phone number to be dialed
OUTFILTER	NewName	LOCAL	Control out-filter function
PARITY		L/R	Set parity options
PICTURE	New	LOCAL	Save a "picture" of the screen to a disk file
PMODE	New	LOCAL	Select CP/M or MS-DOS protocol file transfer processing
PORT	New	LOCAL	Select communication port number
PRINTER	Revised	L/R	Control printer options
PWORD	New	LOCAL	Set answer-mode password
QUIT		LOCAL	Disconnect call and return to DOS
RCVE		L/R	(used internally during file transfers)
RQUEST		LOCAL	Request transfer of file(s)
RXMODEM	New	LOCAL	Receive a file via XMODEM
SAVE		LOCAL	Save operating parameters to a named command file
SEND		LOCAL	Send file(s)
SNAPSHOT	New	LOCAL	Save screen in a buffer for later viewing
SPEED		L/R	Set transmission rate
STOP		L/R	Set number of stop bits
SWITCH	New	LOCAL	Select between terminal and status screens
TABEX		LOCAL	Expand tabs in transmitted file(s) to equivalent number of spaces
TIMER	NewName	LOCAL	Control operation of on-line timer
TURNAROUND	New	LOCAL	Set end-of-line character to send when ENTER key is typed
TYPE	Revised	L/R	View contents of capture buffer or named disk file
UCONLY		LOCAL	Control upper-case-only option
WRITE		L/R	Save data from capture buffer to a disk file
XDOS		LOCAL	Return to DOS but keep call active. Expects you to return!
XMIT		LOCAL	Send file(s) via Crosstalk file transfer protocol
XXMODEM	New	LOCAL	Send a file via XMODEM

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DATA CAPTURE

The CAPTURE command allows incoming data to be saved either in memory or to a disk as it is being received. The status line shows whether the capture function is on, off, or paused and how much memory is available for capturing data. A multitude of options may be used to specify how the captured data are to be saved, viewed (TYPE), ERASEd, and searched (using the command CSTATUS). Excellent error checking prevents the user from accidentally erasing needed data.

A variant of CAPTURE is RETROCAPTURE, invoked by typing "CAPTURE <" and an optional number of lines that should be captured from data that have scrolled off the screen. The user can go back a total of 4,096 characters, provided CAPTURE was not active at the time. If it was, and if it was not paused, the data exist in the main capture buffer and can be TYPEd.

The PICTURE command lets the user store on disk an exact copy of what is on the terminal or the status screen. SNAPSHOT does the same thing, except that its output is retained in a special memory buffer that may be viewed at will. This is handy for storing a bulletin board command menu before switching to expert mode; you can then peek if you forget a command.

If desired, incoming data can be logged to a printer using the PRINTER command followed by an appropriate option to control the printer. Users who are running at 1200 baud or faster will most likely be better off saving to disk or memory and printing later, especially if they're paying for connect time and phone line charges.

The functions that save text files to disk close a file correctly but do not place an end-of-line character at the end of the last text line. This will cause many utility programs that might need to count or print lines from such files to be "off by one" on the short side.

For example, the "1print" program supplied with the Norton Utilities just hangs up after it reaches the end of the last line of a file; the user has to reset the printer manually before proceeding with another file. Many text editors will indicate a "read error" or "incomplete last line" when they encounter the end-of-file character (ASCII 26, ctrl-Z) if there is no end-of-line character (ASCII 10 [line feed], ctrl-J) immediately preceding it.

UNATTENDED ANSWER MODE

All the foregoing commands are used in "call" mode operation; Crosstalk XVI can also operate in the "answer" mode, receiving calls from other systems. Access may be password controlled, and files may be protected to one of four levels.

Callers may execute most Crosstalk commands remotely by preceding them with <Ctrl>–<C> to tell their local system to pass the command to the answering system. The ACCEPT level can be set to everything, nothing, appends, or creates for control over the caller's disk file-writing permission level.

No restrictions are placed by the ACCESS level on reading files and executing other commands, so callers are free to view and copy any files available on the answering system's disks. Beware.

FILE TRANSFERS

The number of file-transfer protocols boggles the mind. The methods divide mainly into text file and binary file transfers.

Crosstalk XVI provides a range of options to handle asynchronous text file transfers with nearly any kind of system. LWAIT and CWAIT provide numerous variations on a theme—assuring that a slow system on the other end receives lines and characters correctly. UCONLY lets the user talk to systems that don't recognize lower-case letters. TABEX and BLANKEX each produce spaces in the transmitted text file to fool a dumb system on

Photo 3: Detailed Help Information

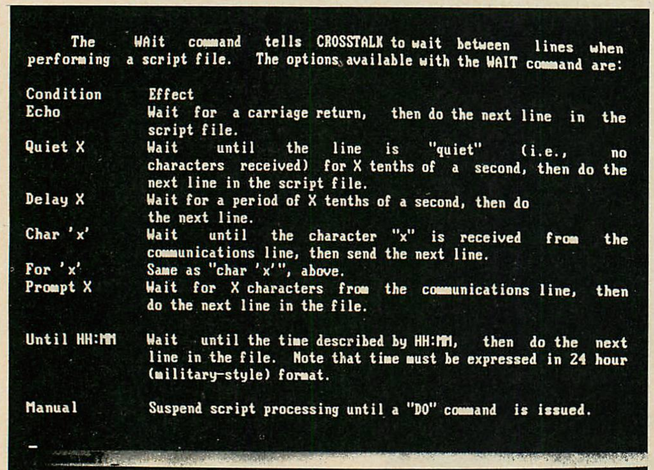
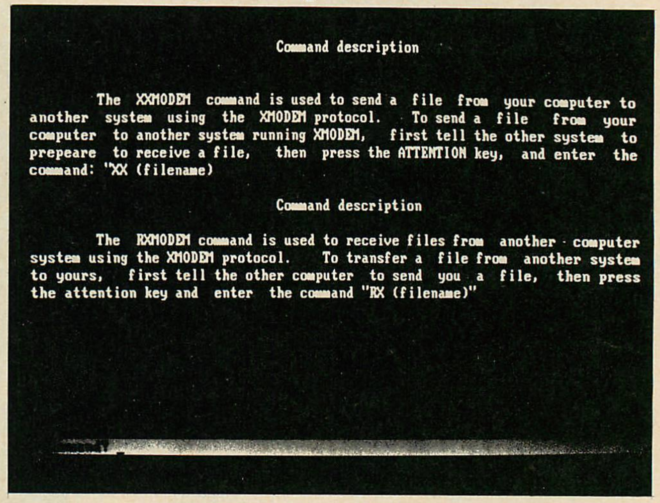


Photo 4: Sample Help Frames

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the receiving end of the path into appropriate behavior when tabs and blank lines are sent.

Special processing is available through OUTFILTER to make IBM text files, which use a combination carriage return/line feed, compatible with other text files that are able to use only one of these line termination characters.

There has been a tremendous increase in the number of executable files being transferred between systems. Hundreds of programs, from gameware to utilities, are available from bulletin boards and other telecommunications services. Because these programs contain binary data, a binary protocol, rather than a program that transfers simple text files, must be used to transfer them between systems.

Crosstalk XVI provides two binary file transfer protocols. As in earlier versions of the program, there is the Crosstalk protocol. The new version also has the public domain XMODEM protocol (starting with version 3.4) that was developed by Ward Christensen and popularized by the many bulletin board systems around the country that use it. The XMODEM protocol is a welcome addition to an already powerful communications package; it makes Crosstalk as useful in personal applications as it has always been in the business world.

The Crosstalk protocol actually is a better binary transfer method than the XMODEM protocol for several reasons. It is more accurate because it uses Cyclical Redundancy Check (CRC) error checking rather than the more easily deceived checksum that XMODEM uses. In addition, it permits directory (multiple file) transfers between compatible systems instead of using the one-at-a-time approach XMODEM uses.

If, for example, a user needs to transfer a bunch of Pascal source files, he can use a wildcard match and the Crosstalk protocol to do it in one smooth operation, simply by typing

XMIT *.pas

The operation can be canceled at any time by typing the "attention" key. RQUEST is the inverse of XMIT.

The XMODEM implementation of Crosstalk fails on one count: it does not always record the correct file size of received text files. This usually is no problem, but if another program has to load a file whose size is not the expected value, there could be surprises.

For example, I ran a series of tests on ordinary text files, and I had some problems. I uploaded a program source file to a host machine and then downloaded it under a different name, using XMODEM

in both directions. The original file was 354 bytes long (12 lines) and became 341 bytes long on the host because CR/NLs were converted to NLs and IBM's end-of-file (EOF) convention—Ctrl-Z—was dropped. When the file was downloaded, it contained all of the original characters but had grown to 384 bytes. Tests with a disk analysis program showed that a string of 30 additional EOF characters was appended to the file and reported as part of its size. The file can still be printed, compiled, and displayed properly because the extra EOFs are ignored, but they should not be there and certainly should not be counted.

COMMAND AND SCRIPT FILES

Much of the power of Crosstalk derives from its use of command and script files. These files each have a special purpose and a unique calling sequence. Command file names are given an extension of .XTK, whereas script file names must have an extension of .XTS.

Any Crosstalk commands may be included in command and script files. In addition, there is a set of special commands intended for use only in script files (see table 2). The user manual incorrectly says that the DO command is a special command for use in scripts only. It is actually a standard LOCAL command that may be used at any time to cause a summary of available script files to be printed (DO), to run a script file (DO script-name), to restart a script (DO after a "WAIT MANUAL" command), or to disable script auto-linking after a connection is established.

A typical command file contains the kind of information that would normally be entered on the status screen before a call to a host computer was placed. The command file becomes a permanent record of that information and may then be called up at a later time to place a call. A built-in "GO R 30" command may be placed at the end of the command file to dial the number automatically, redialing every 30 seconds if necessary, until a connection is established.

The LOAD command, typed with no arguments, produces a list of all available command files and is as close as Crosstalk gets to having a dialing directory. The eight-character limitation on file names results in some cryptic system names.

Listing 1 is a print-out of the command file I use to call a local bulletin board system with good IBM-related material.

A script file, on the other hand, contains instructions about how to carry on a conversation with a host system. This is handy for automating log-in procedures in which known patterns of interactions occur.

The manual contains some good examples of command and script files, including a set for calling The Source, one of the more popular in-

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formation utilities. The script in listing 2, which is taken from the manual, shows how the log-in sequence could be automated. The comments are added to describe what is happening; they do not actually appear in the script file. Lines in a script file that start with a semicolon are ignored, so comments can be added to a file if desired. This is a practice I encourage. You will appreciate these comments when you are trying to figure out what one of your scripts does six

Table 2: Script Commands

Command	Description
ABORT	Cancel currently active script
ALARM	Sound audible alarm signal (4 variations)
ASK	Prompt user for a single character reply
CLEAR	Clear the current screen (only clears display window on status screen)
DO	(this is actually a LOCAL command—see table 1)
IF	Decision command for conditional branching based on answers to "ASK" commands
JUMP	Cause absolute jump to a "label" in the current script. "@" may be used to retrieve the last "ASK."
LABEL	Assign a label to be target of "JUMP" command
MESSAGE	Print a message on the current screen. The message is ended by a dot (".") on a line by itself.
– (NOT)	Used with "IF" to negate test conditions
RWIND	Rewind the current script to the beginning and restart
SBREAK	Send a BREAK signal on the comm line
SCREEN	Select the status or terminal screen. Also sets colors on color/graphics displays. May be used as LOCAL command.
SKIP	Skip a number of lines forward in a script file (not backward not beyond the end of the current script)
REPLY	Send a text string to the host. Used with "WAIT."
WAIT	Wait for a specified condition to be met. Very powerful with many options for real time, received data, time delays, etc.
WHEN	Perform a command WHENever a specified string of characters is received

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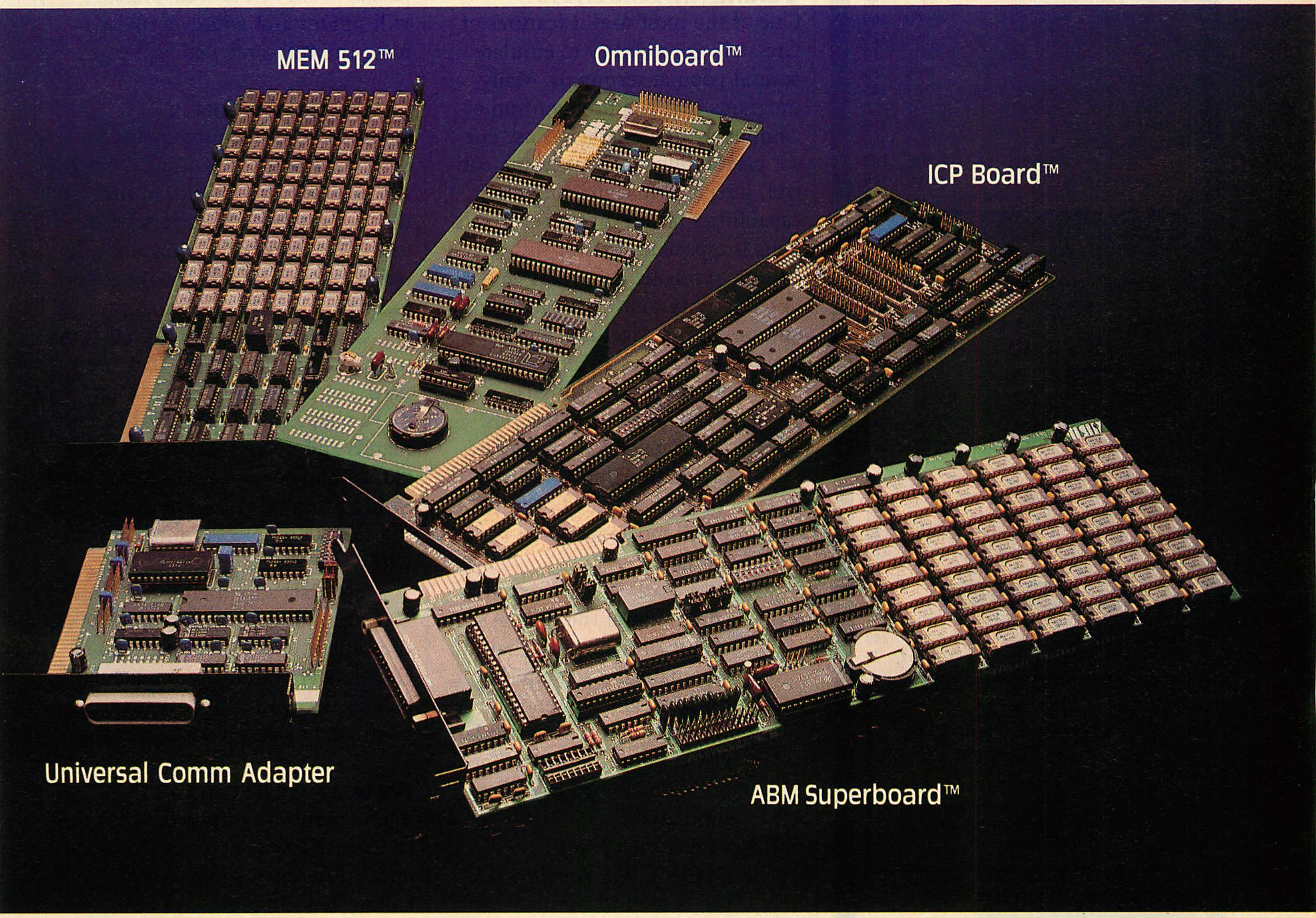

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TERMINAL EMULATION

One of the most useful features of Crosstalk is its ability to emulate several popular terminals. Many programs that run on mainframe computers are designed to use cursor positioning, video attribute control, screen formatting, and other capabilities of intelligent terminals. This is especially true of full-screen editors, symbolic debuggers, and "productivity tools" (spreadsheets and project management aids).

Crosstalk does an admirable job of emulating these terminals:

1. Televideo 910/920 series. The function keys may be programmed to simulate those on the TVI terminal. Block mode operation is not emulated.
2. IBM 3101. This is a good emulation of the 3101 ASCII character-mode terminal. It automatically sets up the function keys to send the same sequences as the PF1-PF8 keys on the 3101. The numeric keypad is also simulated.
3. ADDS Viewpoint.
4. DEC VT-100. An IBM keypad is used to simulate the control and special function keys of a VT-100. It does not emulate the VT-100's double-sized characters, 132-column mode, scroll regions (windows), or smooth scrolling capabilities.
5. DEC VT-52. This can be selected directly from the command line or from the VT-100 mode using that terminal's "go to VT-52 mode" function.
6. TI 940.

I look forward to the day when BBS text editors capable of doing full-screen editing are generally available. The line-oriented editors currently available are clumsy and slow. Their main virtue is that they work with anything on the other end of the line. As more emulation packages are introduced, pressure will mount and will eventually force the full-screen editing issue.

DOCUMENTATION

Crosstalk XVI's documentation is designed to help beginning users get started with a minimum of fuss, yet it is not insulting to experienced users. Thorough indexing and a detailed table of contents make it easy to find most of the information.

Commands are introduced both in the context in which they are used and in an alphabetical summary chapter. Descriptions of commands and operations are written clearly and concisely in English, not in high-tech jargon, so newcomers to the field of telecommunications will not be intimidated.

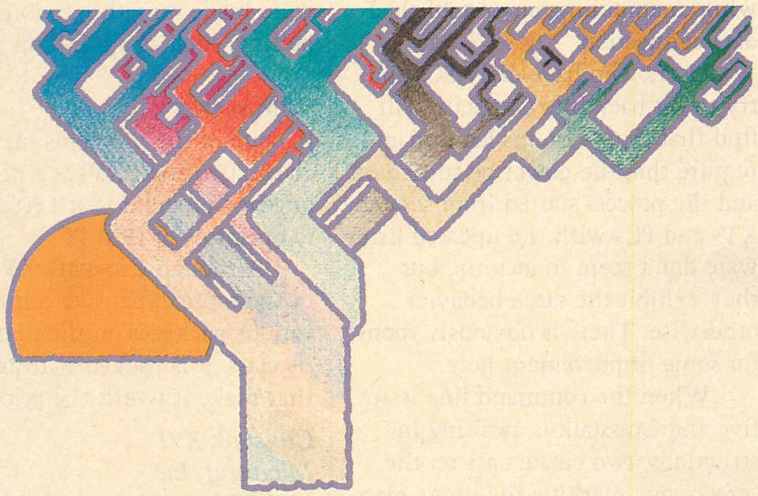
The user's manual is just under 200 pages. Reading the first 35 or so is essential to get started using Crosstalk XVI, but the rest can be read as needed to learn about the program's more advanced features.

NEW AND DIFFERENT

Those familiar with earlier versions of Crosstalk will notice a size difference in the new version. It now comes in a small package that contains a manual in the more convenient and increasingly popular half-sized format, with a slipcase and a program disk.

Early in the manual is the statement: "A word of warning to old (pre-3.0) CROSSTALK users: This version is COMPLETELY different from previous versions." Take heed. There are many new commands, some changes have been made to the names, and, in some cases, changes have been made in the way pre-3.0 commands work. Support has also been added for the public domain XMODEM file transfer protocol and for file path names available under PC-DOS 2.0 and later.

Some command names have



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rather bizarre spellings, which detracts from their mnemonic value. All commands must be uniquely specified in the first two characters, so some of the command names were abbreviated or mutated to preclude naming conflicts. Thus, BKSIZE is used instead of BLOCKSIZE to avoid a collision with BLANKEX and RQUEST is used instead of REQUEST to distinguish the REQUEST command from REPLY. The worst such case is XXMODEM, which is used instead of XMODEM for sending a file under the XMODEM protocol, because the Crosstalk protocol uses XMIT for a command name.

I found one troublesome area related to listing the contents of a disk file using the TYPE command while viewing the status screen. If the file has more lines than will fit in the display window, the user will be prompted to type ENTER to see more of the file's contents. How can such a large listing be terminated? Typing <End> or some other keys produces the same result as typing ENTER. The DOS way of quitting a listing, <Ctrl>–<Break>, makes things really nasty, dumping the user out of the program into DOS, while maintaining any established data connection.

Users who have early PCs and try to get back into Crosstalk will find that their systems lock up and require that the power be turned off and the process started from scratch. XTs and PCs with the updated firmware don't seem to lock up, but they exhibit the same behavior otherwise. There is obviously room for some improvement here.

When the command line is active and Crosstalk is awaiting instructions, two cursors are on the screen, one marking the user's place in the terminal session or just sitting in some odd place on the status screen, the other pointing to the next character of the command sequence. The inactive cursor calls attention to itself by blinking, whereas the command cursor is a fixed underline that is hard to notice. It would be easier for the user if the behaviors of these cursors were reversed or if the command cursor were made something more compelling, such as a blinking block.

SUMMARY

In spite of the problems mentioned above, Crosstalk XVI is a nearly bug-free program that I recommend to operators of IBM PCs.

Although Crosstalk XVI is one of the more expensive communications packages on the market in its class, it is packed with features that make it worth the price.

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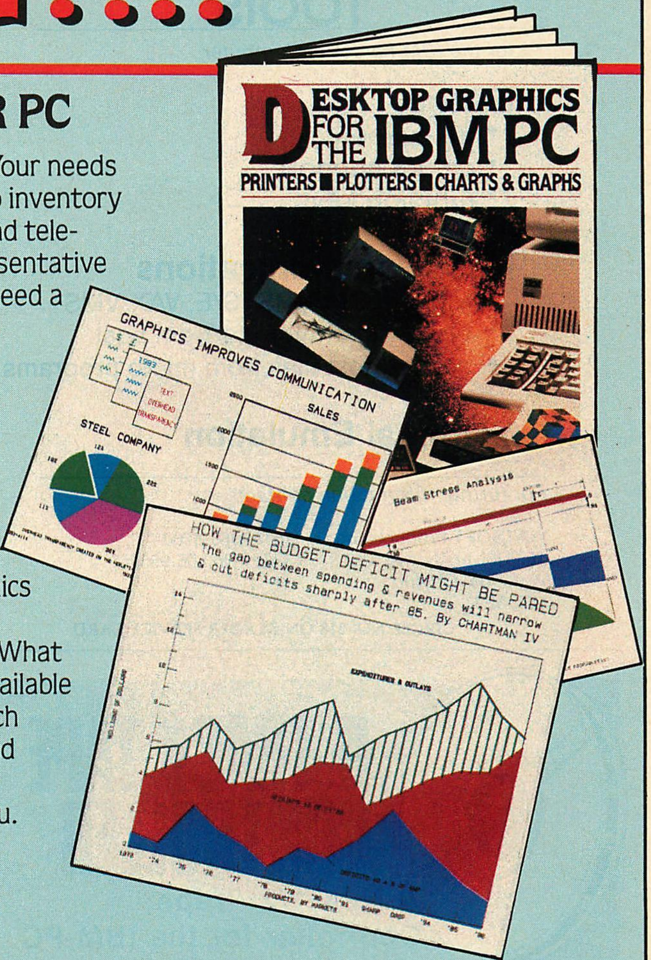

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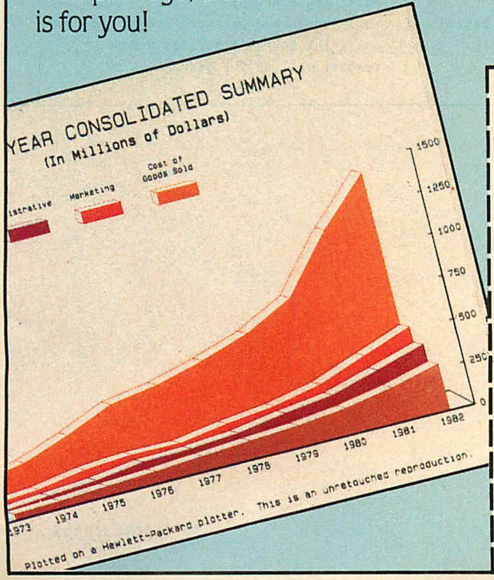

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Listing 1 Sample Command File

```
NAme      RBBS/The Beacon
NUmber    492-1207
ACcept    Everything
ANswback  On
ATten     PgDn
BReak     End
SWitch    Home
CWait     None
LWait     None
DEbug     Off
DPrefix   ATDT
DSuffix   |
EMulate   TVI 920
FIlter    -------++++-++------------------
INfilter  On
LFauto    Off
MOde      Call
POrt      1
PWord     ""
TImer     On
TUrnarnd  Enter
BKsize    1
CApture   Off
COmmand   ETX (Ctrl-C)
DAta      8
DNames    200
DUplex    Full
OUtfiltr  On
PArity    None
PMode     1
PRinter   Off
SPeed     1200
STop      1
TAbex     Off
BLankex   Off
UConly    Off
FK 1 ""
FK 2 ""
FK 3 ""
FK 4 ""
FK 5 @CApture /|
FK 6 @PRinter /|
FK 7 @TYpe|
FK 8 @CApture <24|
FK 9 @SNap|
FK 10 @SNap 24|
GO Q30/30
```

Listing 2 SOURCE.XTS Script File

```
script                          comments (not part of script file)
--------------------------------------------------------------------
wait delay 10                   wait one second (10 tenths)
reply a                         send terminal ID
wait char ":"                   wait for "user name:" prompt
reply ABC10||                   reply with system number
wait char ">"                   await login prompt
reply id abc123 passwd          send log-in and password (these are phoney)
wait char ">"                   await The Source's session prompt
reply mail read|                request mail on The Source
```

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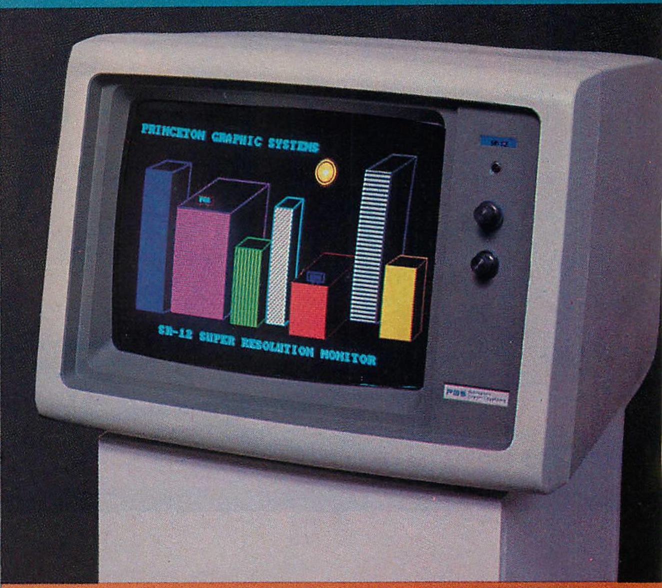

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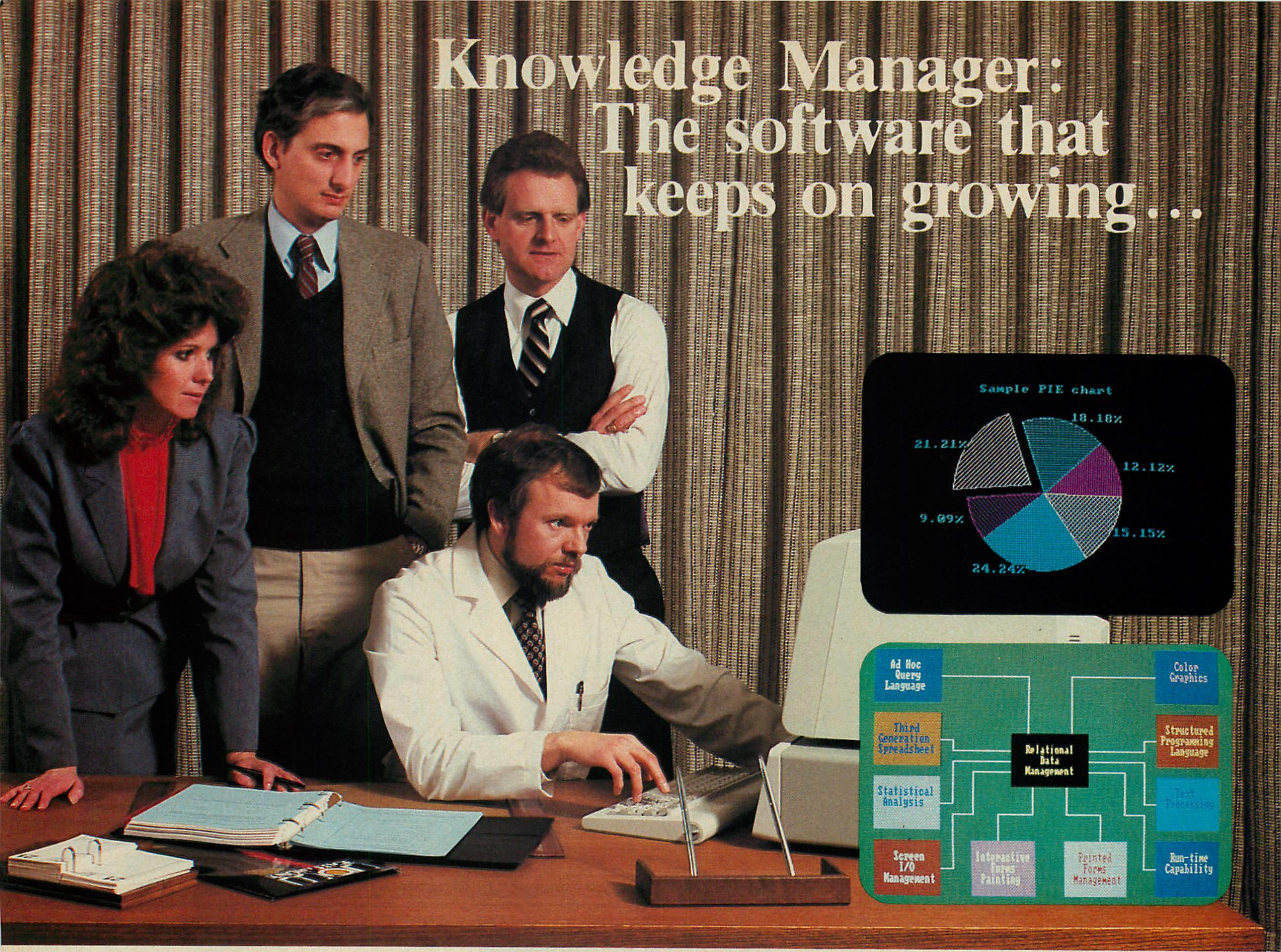

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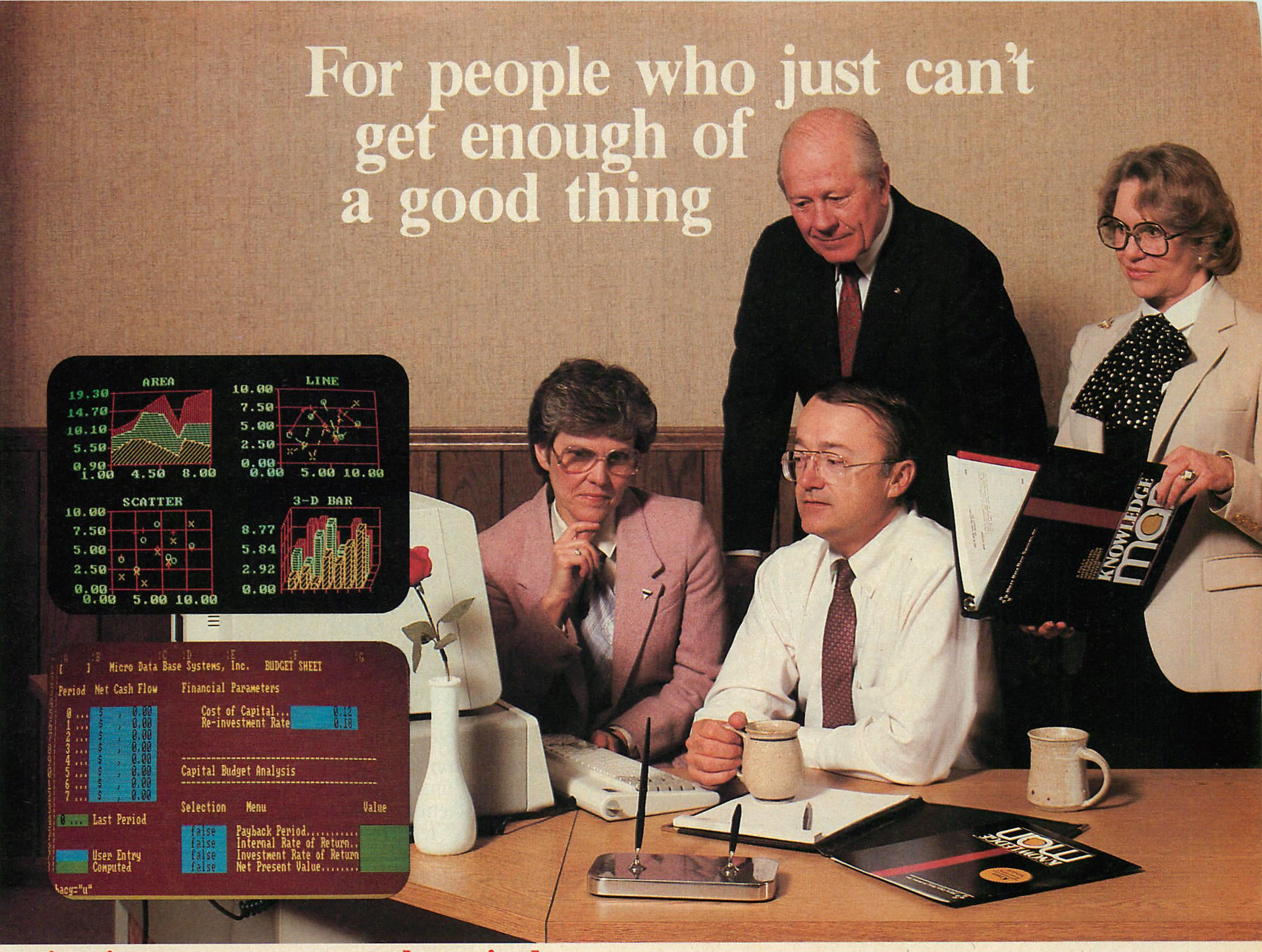

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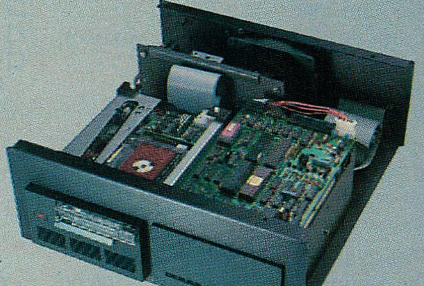

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C. W. HOLSAPPLE

DATA MODELS

A PERSPECTIVE ON DATA MODELS

Tools for managing data—how they work

A key aspect of a computer-based application system is its ability to manage data effectively. PC application developers today can choose from a wide range of software tools that assist in the storing, maintenance, and retrieval of data. The overwhelming majority of these data management tools are file handlers. However, a few of them are highly sophisticated data base management systems with facilities comparable to those normally available with mainframe tools costing $200,000 and more.

In the 1960s, mainframe application systems developers began to demand more sophisticated tools.

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This demand gave birth to the field of data base management, and mainframe data base management systems based on a variety of data models soon followed. It would not be surprising to see a similar (though accelerated) pattern in the micro world. As the demand for more flexible and powerful data management tools grows, mainframe-quality data base management systems will become increasingly important for the PC.

Understanding these data base management systems requires an appreciation of the different data models on which they can be based. Among the five major data models—hierarchical, shallow-network, CODASYL-network, relational, and postrelational—there are both commonalities and differences.

THE NATURE OF DATA BASE MANAGEMENT

A *data base* is a collection in which records of many different types are integrated according to a single logical structure in such a way that data redundancy is eliminated or at least substantially controlled. The logical structure, which defines the types of records that can exist and the natures of their interrelationships, is called the *data base schema.* A *data base management system* (DBMS) is the software tool that allows an application developer to define the data base schema for an application system and then manipulate (create, modify, retrieve) data organized according to that schema.

The foregoing classical definition of the term *data base* is considerably more rigorous than the loose usage that has become commonplace in microcomputing literature over the past few years. In this loose sense, a data base is portrayed as nothing more than any collection of data. Documentation for micro file-management systems routinely uses the terms *data base* and *file* interchangeably. Even some operating systems and spreadsheet packages are now being called data base management systems.

Of course, in the final analysis, what a tool does is more significant than what it is called. However, imprecise usage of the term *data base management* fosters low data management expectations on the part of micro application developers who are inexperienced with classical data base management. They assume that nothing beyond file handling exists; therefore, they are unaware of the greater power and flexibility offered by advanced DBMSs.

A file management system (FMS) allows records of a single type to be stored in an operating system file, separate from other types of records. Normally, an FMS retrieval command is able to operate on only one file at a time. A primitive FMS does not allow data in one file to be combined with data in another file. More advanced FMSs allow users to merge files, based on their redundant data values, to produce new files. The user can devise a series of steps that allows related data stored in multiple files to be incorporated into a new file from which the FMS's retrieval command can produce a desired report. In this manner, the FMS restriction of retrieving from only one file at a time can be circumvented.

As the demand for more flexible and powerful data management tools grows, mainframe-quality data base management systems will become increasingly important for the IBM PC.

File handling is not overly taxing or inefficient for developing simple applications. For more complex applications, however, it often becomes cumbersome and costly, results in substantial data integrity difficulties, and leads to some performance problems.

There are many potential application systems for which file management tools are poorly suited, often to the point that it is technically and/or economically infeasible to use them. It is in such complex applications that developers can realize the biggest payoffs from using a real DBMS. With such a tool, the developer can generally avoid low-level file-merging operations, the production/proliferation of intermediate files, and the data redundancy that results from the forced segregation of records into a multiplicity of separate files. Studying the major data models is one way to begin to appreciate how data base management systems avoid the problems of file management systems.

THE NATURE OF A DATA MODEL

A data model gives a developer facilities for structuring and manipulating descriptions of application worlds. That is, a data model provides formal conventions for specifying a data structure that represents the nature of an application world. Data models differ in their conventions for representing the structure of an application world.

The nature of an application world can be understood in terms of entities, attributes, and relationships. The world is populated with various type of entities. Some of these entity types may be physical, such as customers, employees, or products. Others may be more abstract, such as accounts, jobs, or orders. In either case, an entity can be characterized by one or more attributes. For example, an employee's attributes might be a name, address, and salary, and a job's attributes might include a job description.

Three fundamental types of direct relationships can exist in the real world between two types of entities. A one-to-many relationship can be exemplified by the employee

and his job: one job can be filled by many employees, but no employee fills more than one job. A many-to-many relationship exists between an employee and the skills he possesses: an employee can possess many skills, and a skill can be possessed by many employees. Finally, there is a one-to-one relationship between an employee and his history: each employee can have one history and a history belongs to no more than one employee.

In addition to direct relationships, many types of indirect relationships can exist. (A detailed discussion of the many types of indirect relationships can be found in chapter 7 of *Foundations of Decision Support Systems*, by R. H. Bonczek, et al., Academic Press, 1981.) Indirect relationships involve two entity types that are related only through their relation to a third entity type. For instance, there is an indirect relationship between job and history because both are related to the employee entity type.

In the real world, not all relationships are binary in nature. That is, they do not always involve exactly two entities. For instance, employees can be related to one other by means of a "manage" relationship. This is a recursive one-to-many relationship involving a single entity type: one employee can manage many other employees, but an employee typically can be managed by only one other employee.

Sometimes a single relationship—often called a *forked relationship*—exists among three or more types of entities. For example, consider these three distinct types of entities: hourly employee, salaried employee, and department. A one-to-many forked relationship exists among these entities: one department contains many hourly and/or salaried employees, but each hourly or salaried employee is generally employed by only one department.

As an initial step in building a particular application system, a developer must reach at least an implicit understanding of the entities, attributes, and relationships existing in that application's world. These are then formally represented in terms of the data-structuring conventions provided by a chosen data model. Ideally, a data model's structuring conventions should allow the developer to represent the application world in a natural, straightforward, self-documenting way. The result of this representation process is a data base schema for the application system—a schema that captures all important aspects of the application's entity types, their respective attributes, and their interrelationships. This schema provides the DBMS with a blueprint for organizing the application system's data.

Ideally, a data model's structuring conventions should allow the developer to represent the application world in a natural, straightforward, self-documenting way.

As noted earlier, a data model consists not only of data-structuring conventions but also of a language (or languages) for data access or manipulation. That language is oriented toward the data model's structuring conventions. Within an application system, all requests for data manipulation are stated in terms of the application system's schema. The nature of a data model's access language(s) is strongly influenced by the kinds of schemas that the data model permits.

The Common Basis of the Five Data Models

All five data models take the same basic approach to representing entity types and their attributes. The existence of entities of a particular type is represented in a schema by a record type and its descriptive name (for instance, the existence of employees in the application world might be represented by a record type named EMPLOYEE). A record type is an aggregate of fields that correspond to attributes. These fields are given descriptive names such as ENAME and EADDRESS.

A data base can contain many records of each record type in a schema. The record type defines the logical structure of each of its records. For example, within a data base there can be many records of the EMPLOYEE type, each having a data value for each of EMPLOYEE's fields. In this way, a real-world employee can be described in an EMPLOYEE record in the data base.

Although all data models use the principle of record types and their related fields to model the existence entity types and their related attributes, the terminology can vary from one model to another. In the hierarchical model, record types are often called *segment types* and records are *segments*. In the relational data model, a record type is a *relation structure* or *table structure*, a field is an *attribute*, and a record is a *tuple*. In other data models, fields are sometimes referred to as *data items* and records as *record occurrences*. For uniformity of presentation, the terms *record type, field,* and *record* are used for all data models discussed here.

It is important to bear in mind that record types and their fields exist in a schema, whereas records and their data values exist in the data base itself. The schema is a logical view of how data are organized. The issue of physically implementing a logical view is important, but it is rarely considered a data model topic.

Variations Among the Five Data Models

Although the five data models use the same principle for entity/attribute representation, they differ significantly in their approaches to

representing real-world relationships. Each data model's conventions for representing relationships are examined below, including a discussion of the implications of those conventions for each model's data access languages.

The Relational Model. The relational model was introduced in 1970 by Dr. E. F. Codd of the IBM Research Labs. In this model, relationships are represented by field redundancy in the schema. For example, in figure 1, the fact that employees are related to departments is represented by the appearance of the DEPID field in both the EMPLOYEE record type and the DEPARTMENT record type. The repetition of JOBID in both JOB and EMPLOYEE record types shows that there is a relationship between jobs and employees.

The relational model requires the designer to choose (and, *in some* cases, invent) one or more fields in each record type to serve as the key for that record type (these keys are underlined in the schema of figure 1). A record type's key is unique in that the key value for each record uniquely identifies that record. The key of one record type can be repeated in another record type, in order to represent a relationship.

The schema shown in figure 1 adheres to what is called a *third normal form* (3NF) design. Other normal forms have been identified by relational theorists. It is commonly recommended that developers using a relational schema design their schemas so that they are at least in third normal form. Doing so eliminates some data integrity problems that can otherwise come up during data manipulation.

The topic of normal forms is a complex one that is covered in great length in numerous DBMS textbooks that have appeared since the mid-1970s (see, for example, *Data Base Management Systems*, by A. Cardenas, Allyn & Bacon, 1978). Here, I will limit my examination to the ways in which one-to-one, one-to-many, and many-to-many relationships between record types can be detected in a 3NF schema.

A one-to-one relationship is implied when two record types have the same key. In other words, when the key of one record type is also the key of another record type, the two record types have a one-to-one relationship. For example, because the key field SSNUM is present in both the EMPLOYEE and the HISTORY record types, these types have a one-to-one relationship.

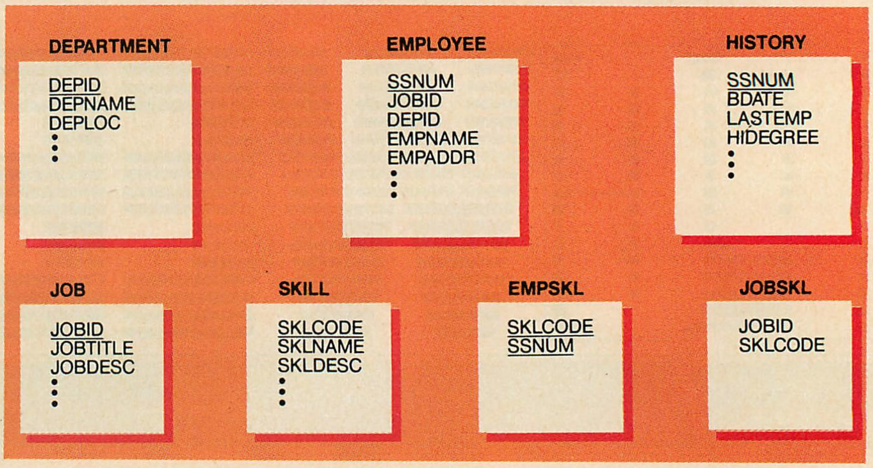
A one-to-many relationship is implied when the key of one record type is repeated, but not as the key,

in a second record type. One record of the first record type can be related to many occurrences of the second record type, but no record occurrence of the second type can be related to more than one record of the first type. For example, the DEPID field is the key for the DEPARTMENT record type, but not for EMPLOYEE. Thus, a department identifier can exist in only one DEPARTMENT record but can exist in many EMPLOYEE records.

In a 3NF relational schema, representation of a direct many-to-many relationship between two entities involves the invention of an extra record type. This record type does not correspond to any real-world entity. Its key consists of the keys of the two record types for which the many-to-many relationship exists, and it has no fields apart from its key.

An example is the EMPSKL record type shown in figure 1. Its key consists of a repetition of the key fields existing in EMPLOYEE and SKILL, and it has no other fields. Any attempt to discover the many employees related to a particular skill or the many skills related to a particular employee must use EMPSKL records. Thus, EMPSKL provides an indirect way of representing the direct many-to-many relationship between employees and skills. Similarly, the many-to-many relationship between jobs and skills is represented by the extra intermediate record type named JOBSKL.

Figure 1: A Sample Relational Schema of Seven Record Types



Languages for accessing a relational data base fall into two broad categories: relational algebra and relational calculus. Both languages require commands to be stated in terms of a relational schema, such

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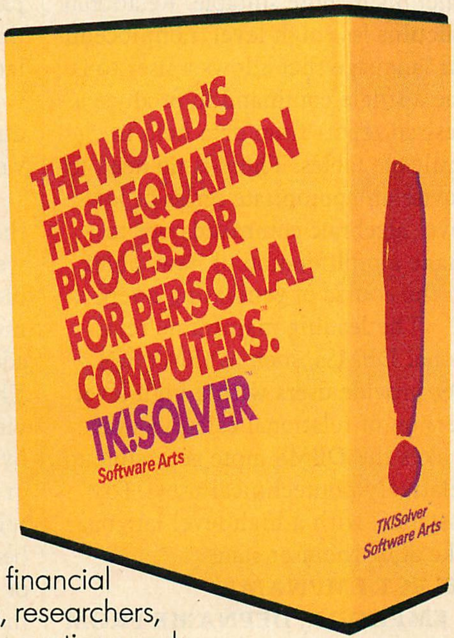

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as the one shown in figure 1. The record occurrences of each record type are often thought of as constituting a table of data. Thus, the user can think of a DEPARTMENT table that is composed of all the DEPARTMENT records for an application, a JOB table that is composed of all JOB records, etc.

Relational algebra provides a group of relatively low-level commands for operating on tables in order to produce new tables. Suppose a user wants to obtain a report based on related data held in multiple tables. With relational algebra this is accomplished by devising an appropriate sequence of commands. Each command in this procedure uses either one or two of the existing tables to generate a new table. After each new table is generated it can be used by subsequent commands in the procedure. Ultimately, the final algebraic command of a procedure generates a new table having all of the desired data.

When only a few tables are involved or when reports do not need to be based on data from multiple tables, using relational algebra is neither overly cumbersome nor time-consuming. In more demanding situations, however, relational calculus is more suitable. Relational calculus is a high-level, nonprocedural language that allows a user to issue a single command to produce a desired report from data held in multiple tables. There is no need to devise an appropriate series of low-level algebraic commands nor to make a proliferation of new tables in the course of generating a report.

The leading mainframe relational DBMSs, such as IBM's SQL/DS, provide users with a high-level version of relational calculus that makes the DBMS more accessible to relatively nontechnical users. For instance, with a high-level language like SQL, the user states

```
SELECT EMPNAME,
  EMPADDR, DEPNAME FROM
  EMPLOYEE, DEPARTMENT
WHERE DEPID IN [7,12,3] AND
  DEPARTMENT.DEPID =
  EMPLOYEE.DEPID
ORDER BY EMPNAME
```

to get a dynamically sorted report of employee names, addresses, and department names for all employees in departments 7, 12, or 3. With relational algebra, the same report would require a multi-step procedure involving the generation of various incidental tables.

Because in a relational schema the user views the data as if they were organized into segregated tables or flat files, many file-management packages for the PC have adopted the "relational" label. These packages also have the user view the world through files related by redundant fields. However, the existence of relational algebra and relational calculus appears to have been largely ignored in the design of many of these packages' file-manipulation languages.

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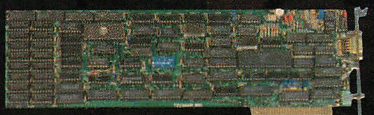

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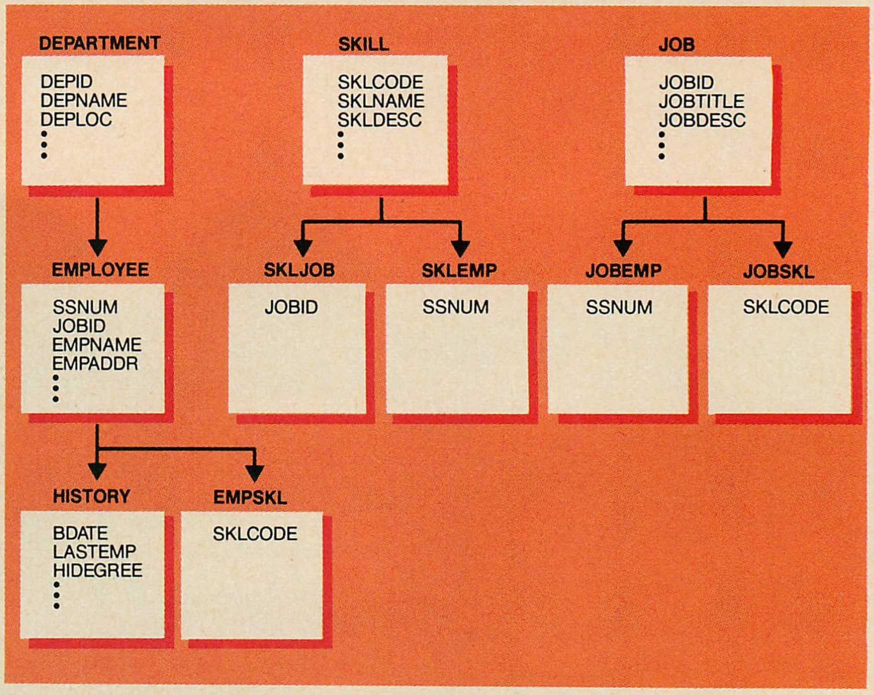
Figure 2: A Sample Hierarchical Schema of Three Hierarchies

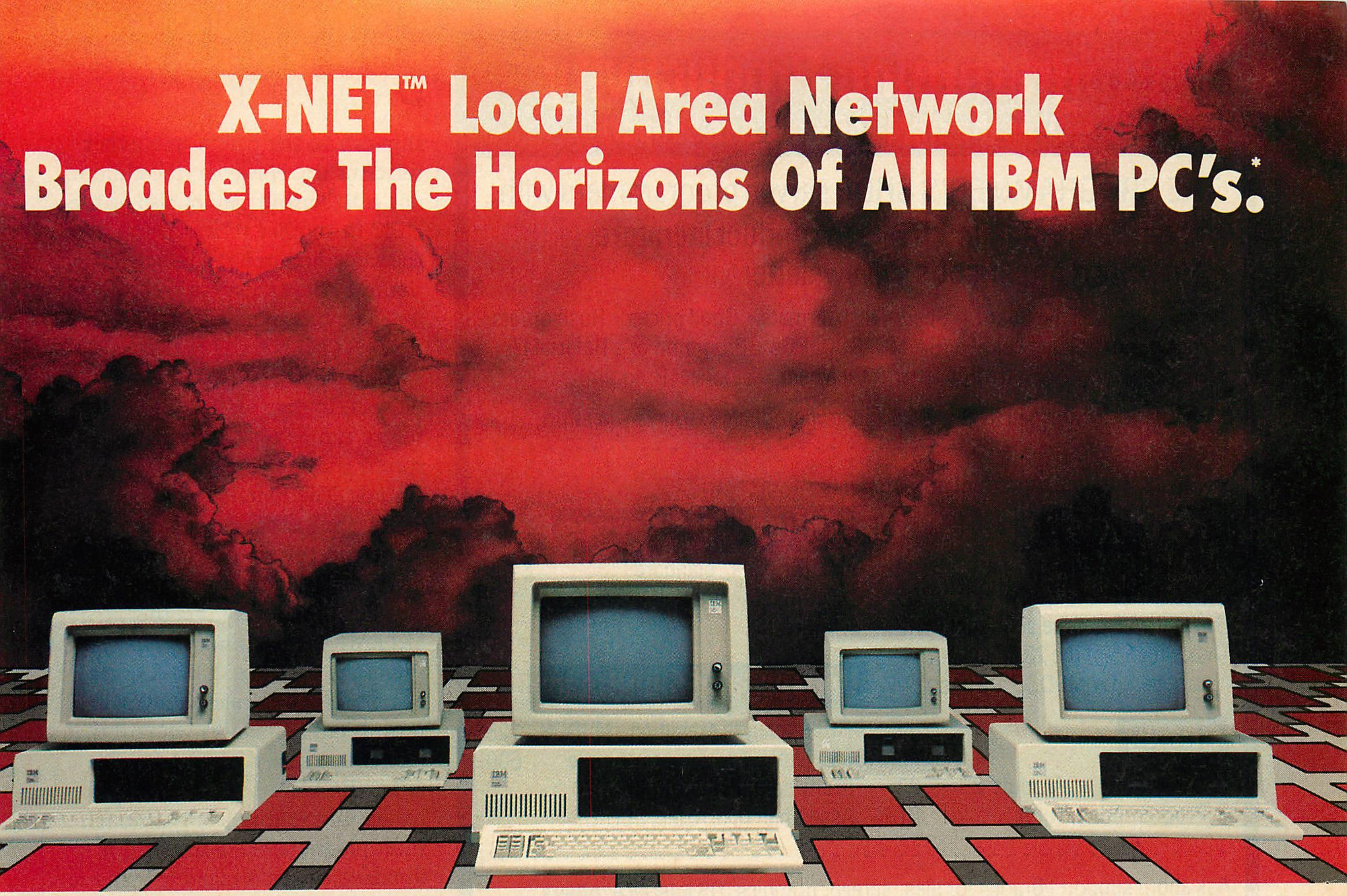


There are exceptions. For instance, the manipulation language provided by the popular dBASE II file handler somewhat resembles a subset of relational algebra. A more rigorous and complete version of relational algebra is offered by MicroRim's R:base package.

Neither of these products, however, supports the high-level SQL language that is commonly available to users of mainframe relational DBMSs. The power of that language is available to PC users with MDBS's Knowledge Manager system. A fairly detailed description of this high-level language appears in "SQL on the IBM PC" (*PC Tech Journal*, November/December 1983). In addition, at least one mainframe vendor of an SQL-like system (called Oracle) has announced its intention to offer a version of this mainframe system for PCs outfitted with relatively extensive (at least .5 Mb) memory capacities.

The Hierarchical Model. Hierarchical DBMSs began appearing in the late 1960s. The hierarchical data model allows the user to represent each one-to-many relationship by designating one record type as the "parent" of the relationship and another record type as the "child." Pictorially, this is portrayed by an arrow from the parent to the child. For instance, in figure 2 the one-to-many relationship between departments and their respective employees is represented by the arrow from the parent DEPARTMENT to the child EMPLOYEE. The designation of a parent-child pair eliminates the need for field redundancy in representing a one-to-many relationship.

The hierarchical data model has no special provisions for representing a one-to-one relationship between two entities. Such a relationship is represented by a parent-child designation, and it is up to the developer/user to remember which of a schema's parent-child couplings refer strictly to one-to-one relationships. Many-to-many relationships cannot be directly represented in a purely hierarchical schema. This is because the overall schematic structure of parent-child couplings is restricted to hierarchies. Within a hierarchy, a child in one relation-



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ship can be the parent in another relationship. However, the child in one relationship cannot also be the child in another relationship within the same hierarchy. The schema of figure 2 obeys this restriction.

The hierarchy stemming from DEPARTMENT shows that a department can have many employees. In turn, each EMPLOYEE record can be related to a HISTORY record and to many EMPSKL records. The hierarchy headed by SKILL shows that a particular skill can be needed in many jobs (via the SKLJOB child) and can be possessed by many employees (via the SKLEMP child). Similarly, the third hierarchy specifies that a JOB record can be related to many JOBEMP records (all employees who fill that job) and to many JOBSKL records (all skills needed for that job).

Notice that it is only through multiple hierarchies and field redundancies that a many-to-many relationship can be represented in a hierarchical schema. For instance, EMPLOYEE and its EMPSKL child represent only part of the many-to-many relationship that exists between employees and skills. The other part is captured by SKILL and its SKLEMP child. As in a relational 3NF schema, some record types in the hierarchical schema do not represent entities, but instead have been added to help represent the real-world relationships that exist among entities.

Languages for processing the data in a hierarchical data base vary from one implementation to another but have several traits in common. Typically, an individual command operates on data within one hierarchy at a time. The data access can begin at the head of the hierarchy or lower. Processing must generally move downward in the hierarchy, from parent to child. This means that if a user begins by accessing a particular EMPLOYEE record, he cannot then access the DEPARTMENT record to which it

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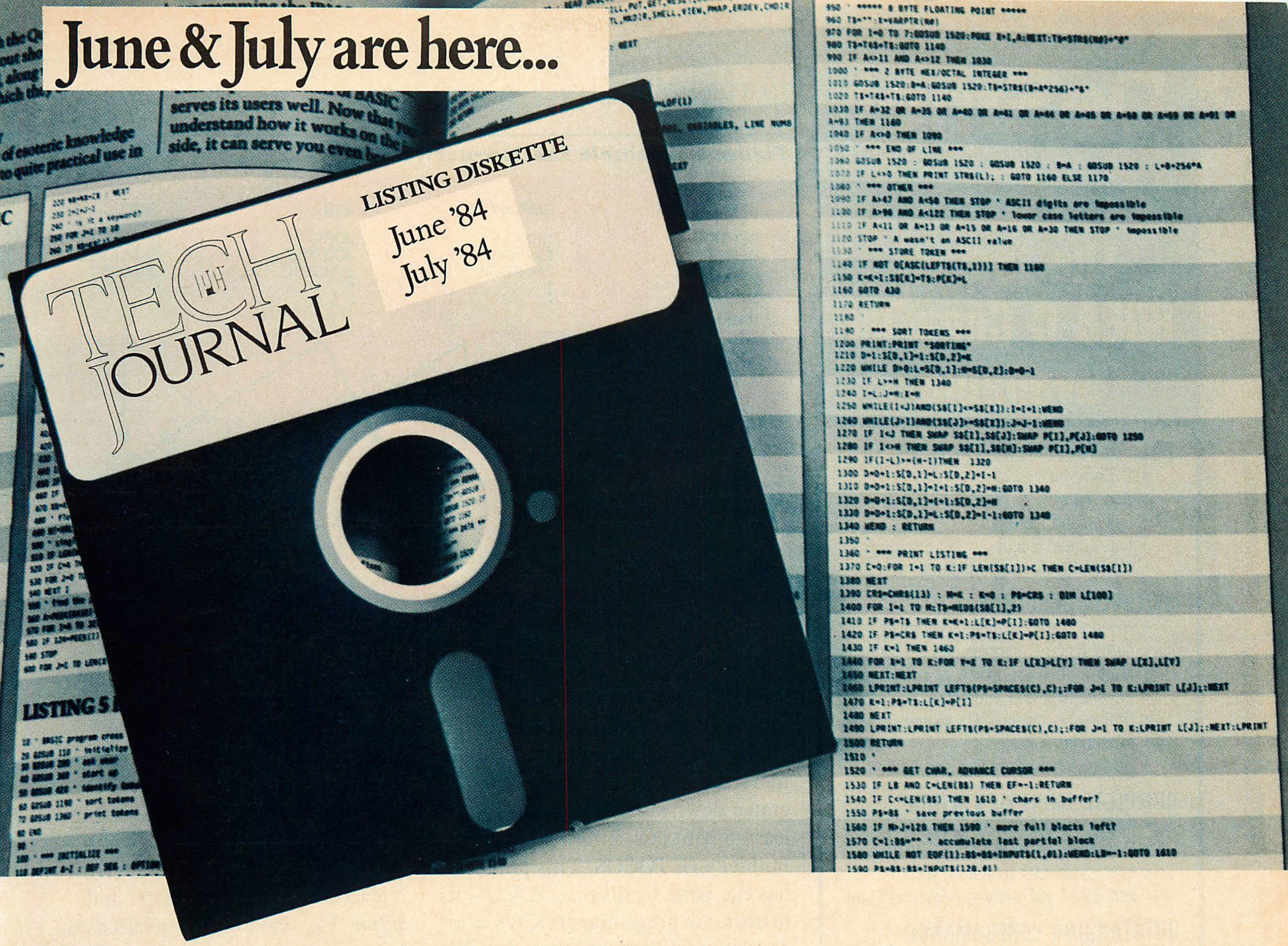

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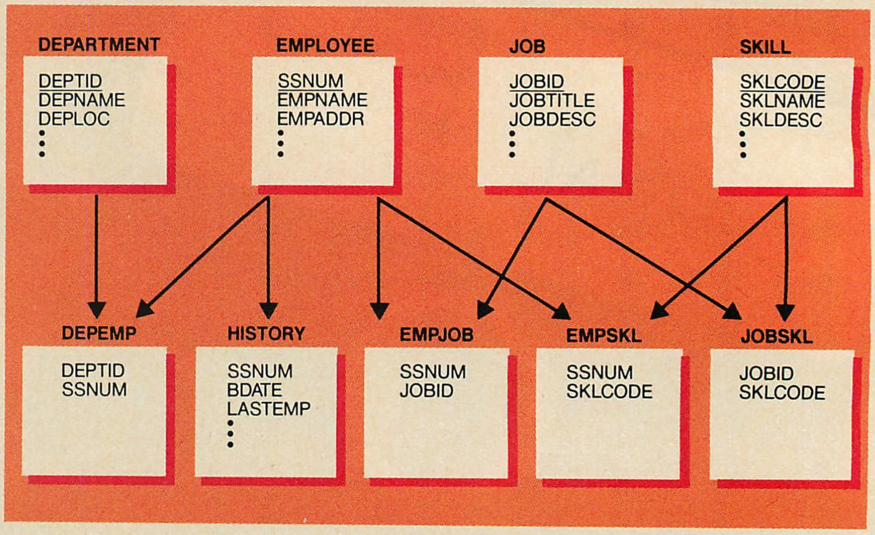
Figure 3: A Sample Shallow-network Schema



is related. He can, however, access the HISTORY and EMPSKL records related to that EMPLOYEE record.

There is at least one mainframe hierarchical DBMS that has migrated downward to run on large (at least .8 Mb) PCs: Information Builder's PC-FOCUS. This product has the same facilities as FOCUS, its mainframe progenitor. FOCUS is a derivative of Mathematica's hierarchical RAMIS DBMS which first appeared in the late 1960s.

Because of the relative inflexibility and working difficulty of the hierarchical approach, it would be surprising to see many new hierarchical DBMSs appearing for the PC. Micro hierarchical systems will be of interest primarily to those who are well-accustomed to working within the constraints of a mainframe hierarchical DBMS.

The Shallow-network Model. The shallow-network approach to data base organization and processing emerged in the late 1960s. Sometimes shallow-network and CODASYL-network models are broadly grouped under the heading *network*. The differences between the shallow-network and CODASYL-network models are, however, every bit as great as those between the hierarchical and CODASYL-network models. Like the hierarchical model, a shallow-network schema can directly represent one-to-many relationships; as they are in the hierarchical model, such relationships are traditionally portrayed with arrows. In the shallow-network model, however, the hierarchical parent-child terminology is replaced by the terms *master* and *detail*. The one-to-many relationship from a master record type to a detail record type is called a *linkage path*.

Recall that in the hierarchical model no record type can be the child of more than one parent. This restriction does not exist in shallow-network systems. A record type can serve as the detail for multiple linkage paths. As the structure of figure 3 suggests, however, there is a restriction on the configuration of linkage paths in a shallow-network schema. A record type that is the detail for a linkage path cannot also be the master for a linkage path. The result is a schema that has only two levels and is therefore called shallow. This restriction does not exist in a hierarchical schema, in which the child of one relationship can be the parent of another.

Every master record type in a shallow-network schema must have one or more fields that serve as unique identifiers. (Keys of the four master record types in figure 3 are

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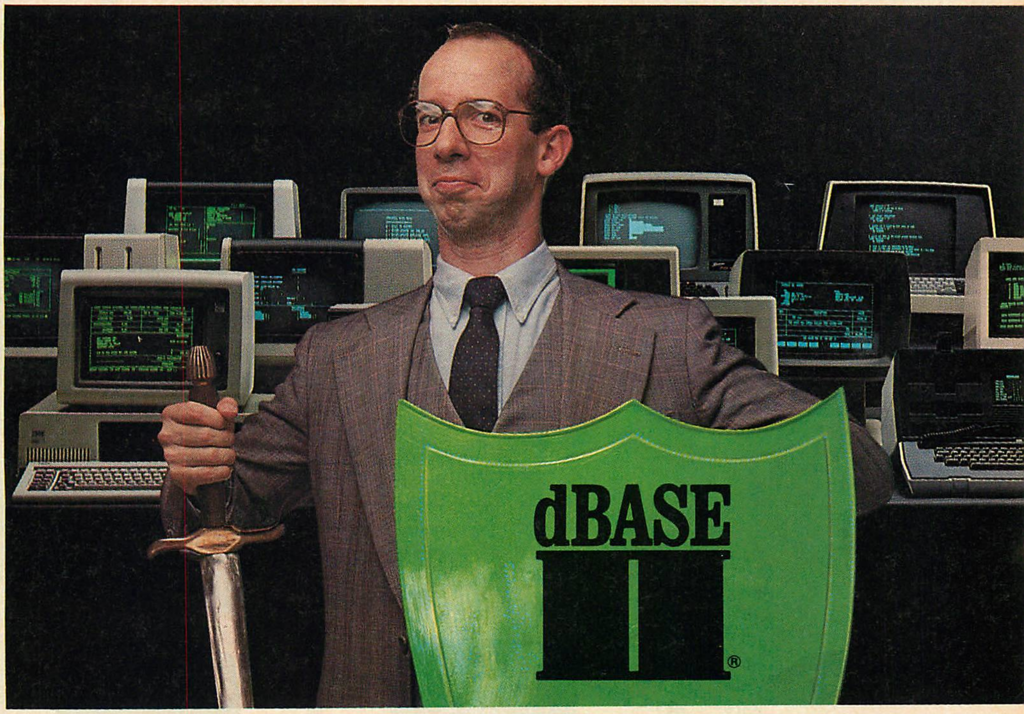

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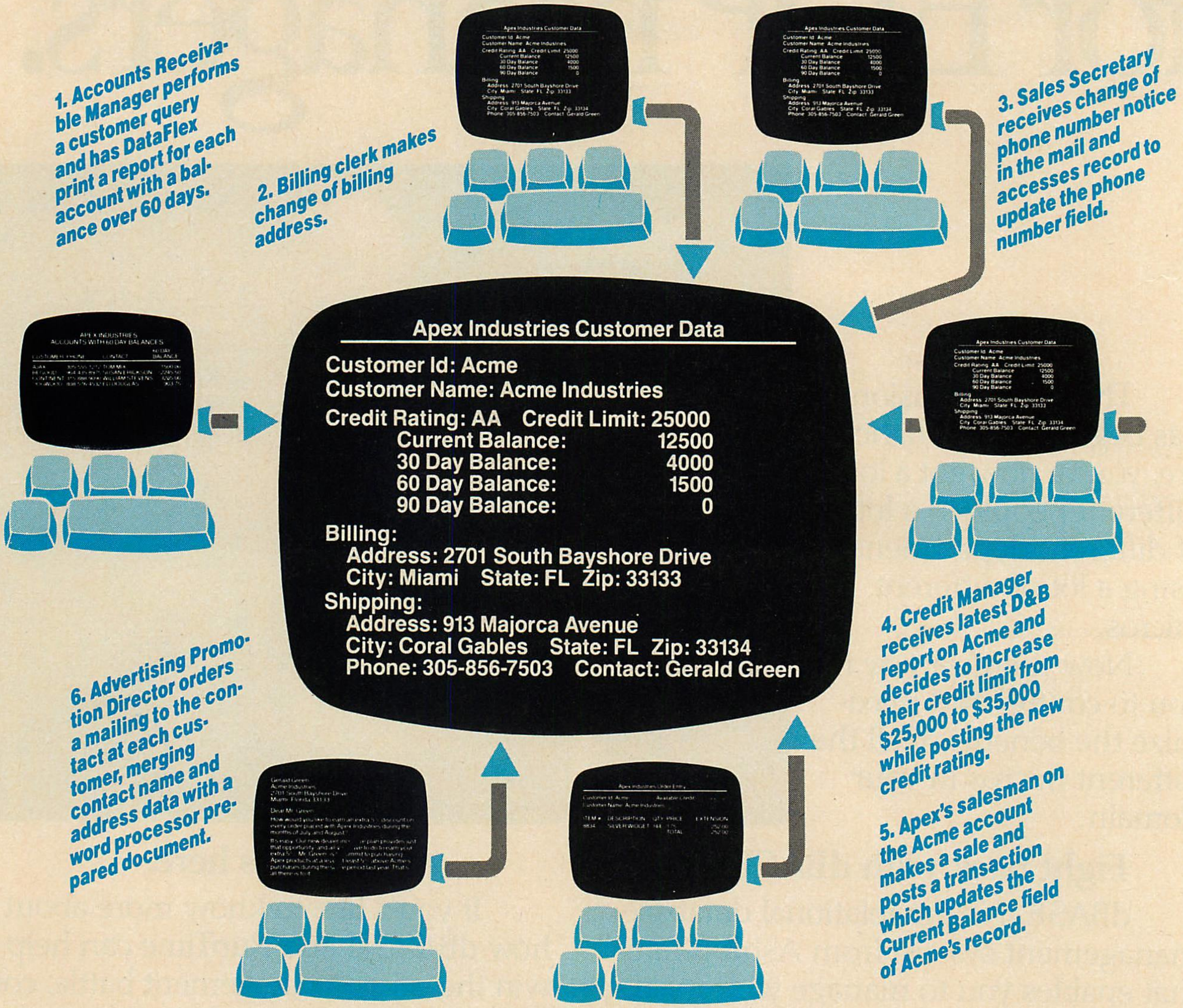

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underlined.) Furthermore, the shallow-network model requires that the key for a master record type be repeated in every detail record type linked to that master. For instance, the SSNUM key of the master record EMPLOYEE is repeated in each of its four detail record types.

As with the hierarchical model, structural restrictions force the developer to invent extra record types when designing a shallow-network schema. These extra record types exist solely to help represent certain kinds of relationships. For instance, the EMPSKL detail record type, together with its two linkage paths, exists solely to represent the many-to-many relationship between employees and skills. Through one of these linkage paths, a given EMPLOYEE record can be related to many EMPSKL records, each of which is related to a particular SKILL record through the other linkage path. Conversely, a given SKILL record can be related to many EMPSKL records, each of which is related to one EMPLOYEE record. Thus, the direct many-to-many relationship between skills and employees can be represented indirectly in a shallow-network schema.

The data access language of the shallow-network model is able to process in both directions along an access path. Processing begins by accessing a desired record of any of the master record types. From this master record, processing can access any of the related detail records. Once a detail record has been accessed, commands are available to find any master record that is related to it. Thus, to find what skills a particular employee possesses, the employee's social security number is used to access his EMPLOYEE record. After that, each EMPSKL record related to EMPLOYEE is accessed, and then a further access is made to that record's SKILL master record. In the final step, the SKLNAME data from the SKILL master record are read.

Cincom's TOTAL is a shallow-network DBMS that is operable in a wide range of mini and mainframe environments. HP's IMAGE is a derivative of TOTAL that is available on HP minis. These systems have not yet migrated to the PC. Technically, there should be no problem in implementing a shallow-network system for the PC.

The CODASYL-network Model. In 1971 the CODASYL Data Base Task Group published a report specifying the data-structuring and data-manipulation facilities of the CODASYL-network model. Like the earlier shallow-network and hierarchical data models, this model allows one-to-many relationships to be represented without resorting to field redundancy. It does not, however, restrict the overall configuration of a schema to a hierarchical or a shallow-network pattern. As a result, this model permits simpler schemas and less cumbersome processing.

With the CODASYL-network approach, an application developer does not have to devise ways of representing the nonhierarchical world in terms of hierarchies. Nor is the developer forced to try to represent multi-level worlds in terms of shallow networks. This model allows any record type to be both an owner and a member of multiple sets.

The CODASYL term *owner* is like the hierarchical term *parent* and the shallow-network term *master*. Similarly, a member record type is akin to a child or detail record type. The CODASYL term *set* refers to a one-to-many relationship between two record types, one of which is called the set's owner and the other of which is the set's member record type. A set, therefore, corresponds to a linkage path and to a parent-child relationship.

Each set in a CODASYL schema is given a unique name and is represented by the traditional arrow pointing from the set's owner to the set's member record type. For instance, the CONTAINS set in figure 4 represents the one-to-many relationship between departments and employees. DEPARTMENT is the owner of CONTAINS, and EMPLOYEE is the member.

Like the earlier data models, the CODASYL-network approach makes no special allowance for one-to-one relationships. These are represented in the same way as one-to-many relationships, with the result that a single construct is used to depict two very different situations. It is up to the developer (or user) to remember which sets are actually intended to represent one-to-one rather than one-to-many relationships. Unlike earlier models, the CODASYL schema allows multiple sets between two record types.

To represent the existence of a direct many-to-many relationship between entities, the CODASYL approach makes use of an extra record type and two sets. In figure 4 the

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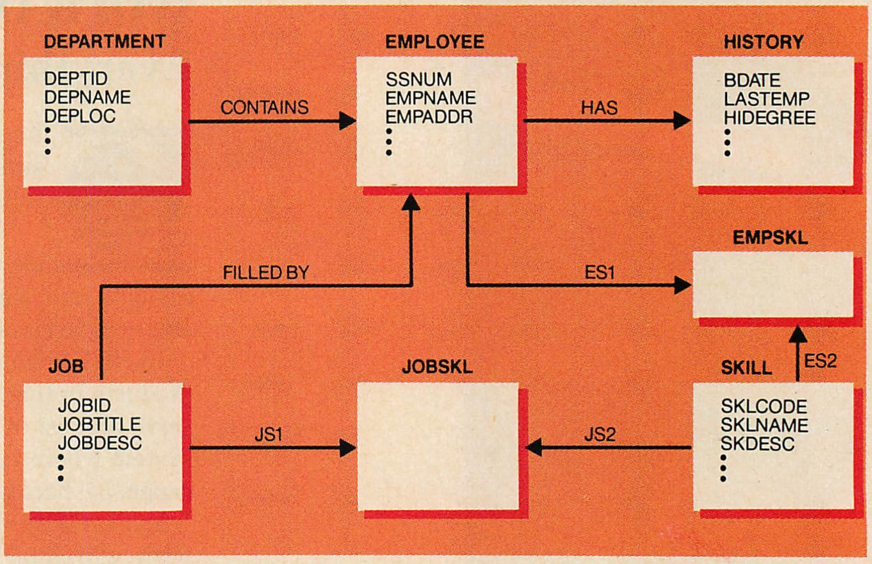
Figure 4: A Sample CODASYL-network Schema



many-to-many relationship between employees and skills is shown by the artificial record type EMPSKL and the two sets (ES1 and ES2) to which it belongs. This record type has no fields and corresponds to no real-world entities. Its records have no data values, but they are vital in relating EMPLOYEE records to SKILL records.

Through the ES1 set, each EMPLOYEE record can be related to many EMPSKL records. Each of these dataless records is, in turn, related to a particular SKILL record by the ES2 set. Thus, all skills of an employee can be found. Conversely, the ES2 set can relate each SKILL record to many EMPSKL records, each of which is related to a particular EMPLOYEE record. In this way, all employees having a particular skill can be found.

It is instructive to compare the schemas of figures 1 and 4. Conversion from one to the other is a simple matter. Each schema has an identical number of record types. Although the CODASYL-network schema does not require a unique key for every record type, a key can be designated for each record type that owns a set (e.g., JOBID for JOB). If each set in figure 4 is eliminated and the key of its owning record type is repeated in its member record type, the relational schema shown in figure 1 is the result. The reverse transformation is achieved by eliminating repeated keys in favor of labeled arrows. Notice that both schemas require the use of record types to represent many-to-many relationships.

Structurally, the relational and CODASYL-network models are closer to each other than to the older hierarchical and shallow-network models. Perhaps the most significant difference between the relational and CODASYL schemas is the CODASYL model's ability to show more clearly the semantics of one-to-many relationships. Each set can be labeled with a descriptive name indicating the meaning of the relationship. Furthermore, the existence of each relationship can be seen immediately without hunting for duplicate key fields.

For small schemas, such as the example used here or those commonly found in DBMS textbooks, these distinctions may not be important. For larger schemas encountered in practice (for example, those with dozens of record types and relationships), however, the clear representation of relationships and their meanings is valuable.

Data models

The CODASYL model's data-manipulation language is oriented toward processing one record at a time. Processing can start with an occurrence of any record type. Commands are then available to find a related record of some other type via a set. This related record may be the owner record for a particular member or one of the member records related to the previously found owner record. At any stage in a processing procedure, only the most recently found record can be acted upon (modified, viewed, deleted). The DBTG Report did not propose a higher-level nonprocedural language for data access. However, some DBMS implementations based on the CODASYL model have added various higher-level languages.

CODASYL-network systems have become widely used in developing mainframe application systems over the past decade. Perhaps the best known of these is Cullinet's IDMS. Honeywell's IDS II and Univac's DMS 1100 are also prominent. Presently, there are no significant CODASYL-network DBMSs available for the PC.

The Postrelational Model. Just as the relational and CODASYL-network models overcame certain limitations of the earlier hierarchical and shallow-network approaches, a more recent data model endeavors to improve upon the relational and CODASYL-network approaches. This new model has been called *postrelational, extended-network*, and *multiarchical*. All these labels suggest the extent to which this model retains the respective strengths of earlier models while relaxing the restrictions they place on a system developer. I use the term *postrelational* here.

The postrelational approach appeared in the late 1970s and early 1980s (see *Foundations of Decision Support Systems*, by R. H. Bonczek, et al., Academic Press, 1981) and emphasizes straightforward, natural representation of the many relation-

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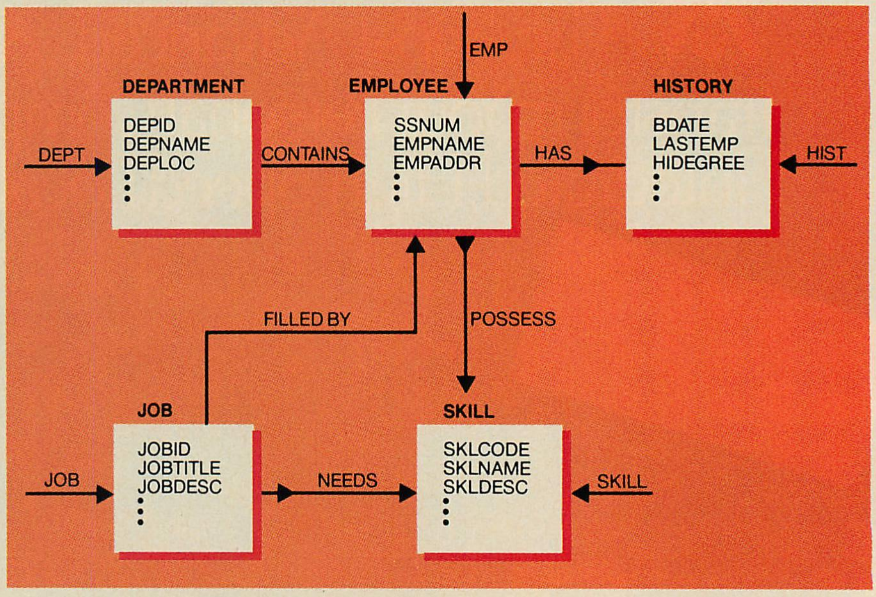
Figure 5: A Sample Postrelational Schema



ships that exist in the real world. It introduces fundamentally new constructs for specifying a data base's logical structure. Some of these constructs are illustrated in the postrelational schema of figure 5.

One-to-many relationships (CONTAINS and FILLEDBY, for example), are represented as they are in the CODASYL-network model. These are called 1:N sets, and there is no structural restriction on their use in a schema. One-to-one relationships are directly represented by 1:1 sets. Pictorially, a 1:1 set is denoted by an arrow in the middle of a shank (see HAS in figure 5 for example). The existence of this new construct means that the integrity of one-to-one relationships is automatically guaranteed; this guarantee does not exist in earlier models, in which one-to-one relationships are represented the same as one-to-many relationships.

Another new construct is the N:M set, which allows direct many-to-many relationships to be represented immediately without redundancy and without extra or artificial record types having to be contrived. This is why figure 5 has two fewer record types than figure 1 or figure 4. Each N:M set is indicated by double arrows pointing from an owning record type to a member record type. The many-to-many relationship between employees and skills is represented by the POSSESS N:M set. Similarly, the NEEDS N:M set directly represents the relationship between employees and skills.

The postrelational model places no restrictions on the overall configuration of 1:N sets, 1:1 sets, or N:M sets in a schema. Any of these types of sets can be used recursively in a schema to represent a recursive relationship that is present in the application world.

Two common examples of this characteristic are shown in figure 6. By adding a TRAINING record type with the PASSED N:M set for EMPLOYEE, the user can keep track of which subjects each employee has passed and which employees have passed any particular subject. One example of recursion is MANAGE. This is a 1:N set having the EMPLOYEE record type as both owner and member. It is a simple way of representing the one-to-many relationship that exists among employees: an employee can manage many other employees, but an employee is usually managed by at most one other employee.

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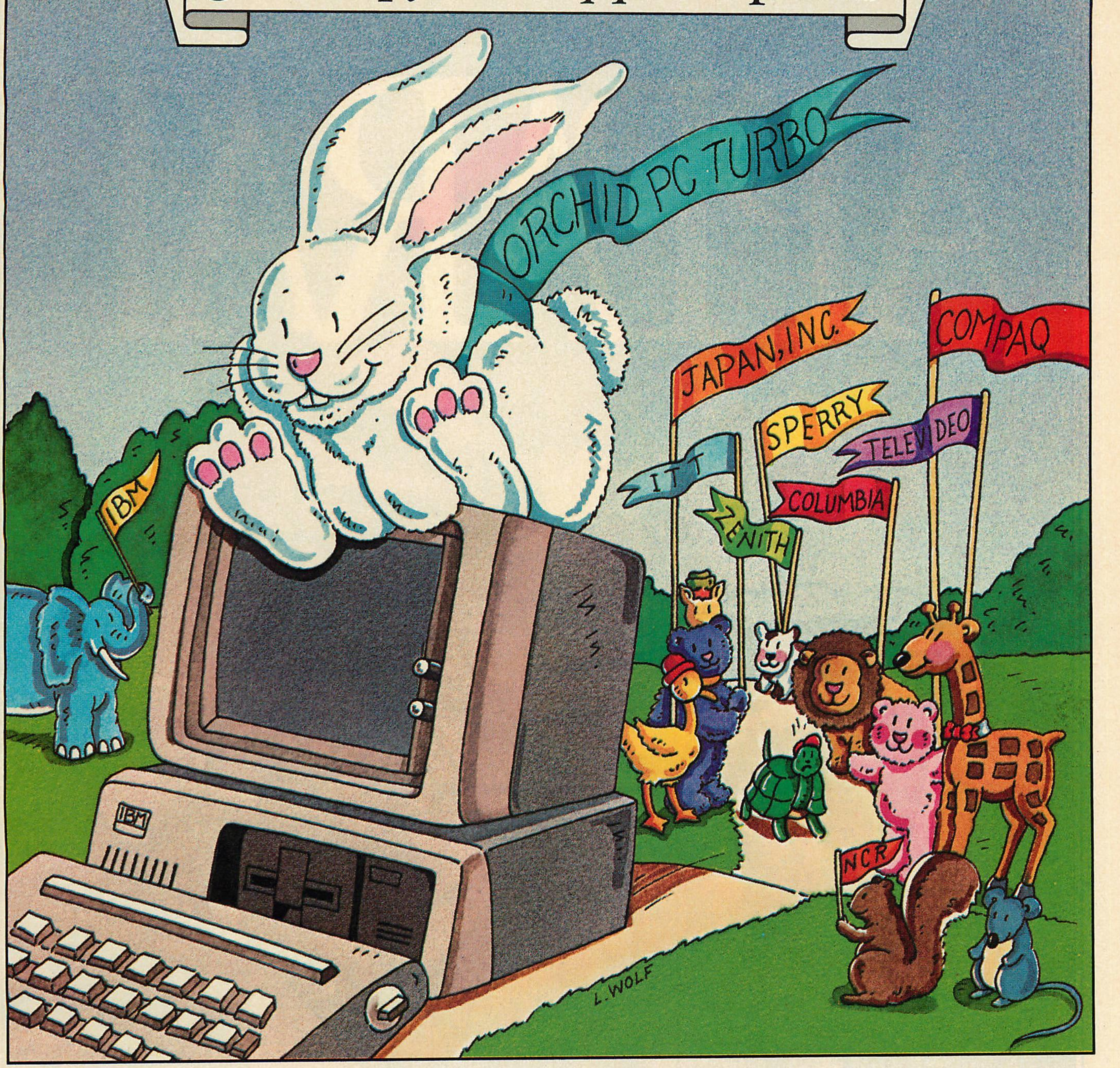

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Figure 6: Examples of Recursion in a Postrelational Schema

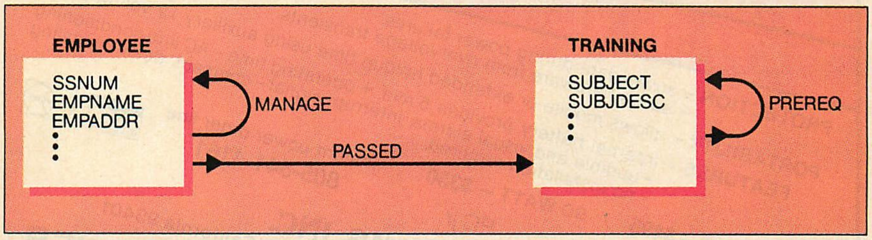
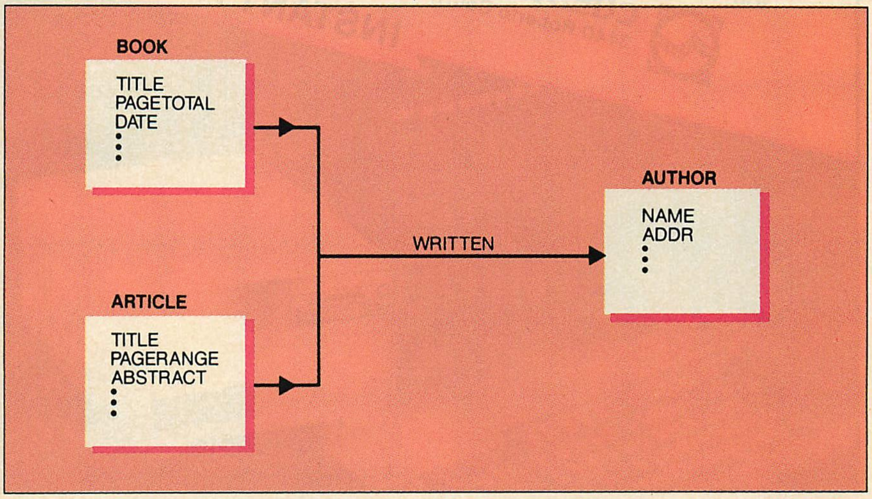


Figure 7: A Forked Relationship in a Postrelational Schema



The second example of recursion is PREREQ. This is an N:M set with TRAINING as both the owner and member record type. It compactly represents the fact that any subject can have many prerequisite subjects and can, at the same time, be a prerequisite for many other subjects. The older data models can do this, too, but only by means of redundancy and/or invention of extraneous record types.

Yet another kind of real-world relationship that is easily represented in the postrelational model is a forked relationship involving more than two entities. The postrelational model allows any 1:1, 1:N, or N:M set to have multiple owning and/or member record types.

A common example is shown in figure 7. In the real world, authors can write books and/or articles; a book or article could have been written by one or more authors. This single "writing" relationship therefore involves three distinct entities: books, articles, and authors. It is a many-to-many relationship between books/articles on the one hand and authors on the other. This situation is represented by a single forked N:M set (WRITTEN) in a postrelational schema.

Even the direct representation of recursive forked relationships is supported by the postrelational model. With the exception of one special case handled by CODASYL-networks, the representation of forked relationships is highly problematic with earlier data models.

It should be clear that the postrelational data structuring methods closely mirror the nature of the real world. One implication of this flexibility is that a developer need not perform various design tricks and contortions to represent real-world relationships indirectly. Instead, such relationships are represented concisely in such a way that the semantics of each relationship is readily apparent from the schema.

Like the relational model, the postrelational has a low-level access

language and a high-level access language. The low-level language is procedural in orientation. It provides commands for record-at-a-time processing and other commands that operate on entire groups of records (of the same or different types) within the scope of a single command. The record-oriented commands resemble the CODASYL data-manipulation language in spirit, although they are different in form and yield a more streamlined processing logic. The nearest counterpart to the group-oriented commands is relational algebra.

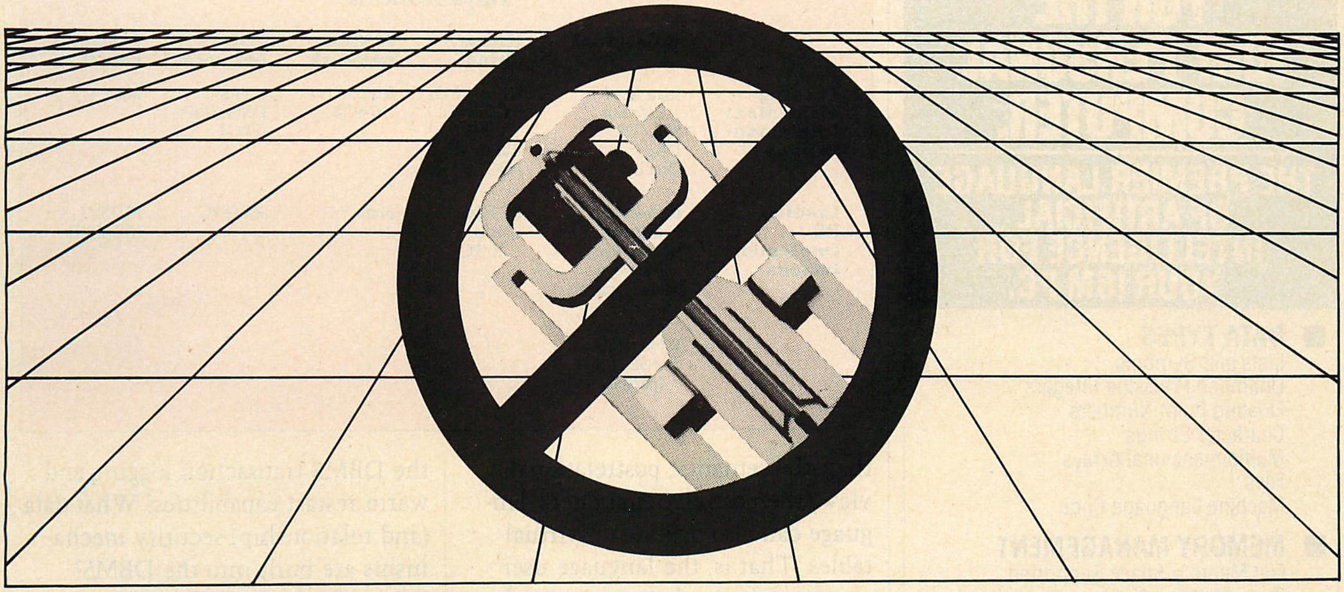
One implication of the flexibility of the postrelational data structuring methods is that a developer need not perform various design tricks and contortions to indirectly represent real-world relationships.

The high-level access language supports retrieval commands that are functionally equivalent to SQL retrieval. The postrelational query tends to be less complex than its SQL counterpart, however, because the user does not need to state all record types (i.e., tables) that are to be used or the relationships that are to be used in terms of equating the redundant fields. Instead, the user states the names of the relationships that are to be used for the retrieval. The example of an SQL query given earlier in the discussion of the relational model would be, in the post-relational model:

```
LIST EMPNAME, EMPADDR,
  DEPNAME FOR DEPID IN
  [7,12,3] THRU DEPT,
  CONTAINS
```

For users who prefer a flat-file, tabular view of data organization rather

No Head is Better than One!



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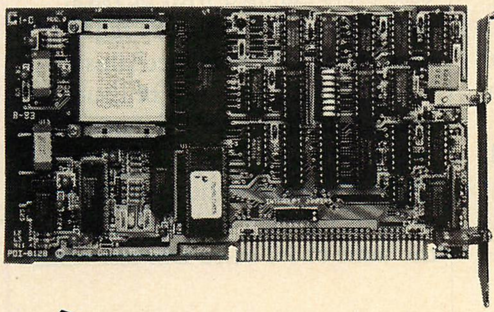

PDIB-384

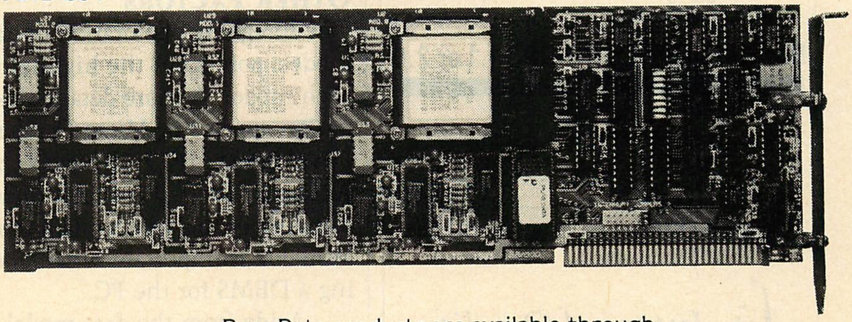

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Figure 8: Data Model Implementations

	Data Models				
	Relational	**Hierarchical**	**Shallow-network**	**CODASYL-network**	**Postrelational**
Leading Mini/Maxi Implementations	*high-level calculus* SQL/DS DB2 Oracle	DL/1 (IMS) SYSTEM 2000 Ramis II FOCUS	TOTAL IMAGE	IDMS DMS 1100 IDS II	none
Leading PC Implementations	*high-level calculus* Knowledge Manager Micro-Oracle *low-level algebra* R:base 4000 dBASE II (partial)	PC-FOCUS Ramis II/PC	none	SEED-PC	MDBS I MDBS III

than the semantic postrelational view, the postrelational query language can also operate on virtual tables. That is, the language user can view data as being organized into a table (for example, a "relation" or flat file) and can state requests based on that view. In reality, the inefficiencies of actual tables or flat files are not incurred.

The initial implementations of the postrelational model have appeared in the realm of minis and 8-bit micros. The Micro Data Base Systems, Inc. postrelational MDBS III became available for the PC in 1982. This implementation is native to the PC rather than being a migrator from the mainframe world. As a result, it is operable with modest memory resources (e.g., 128 Kb).

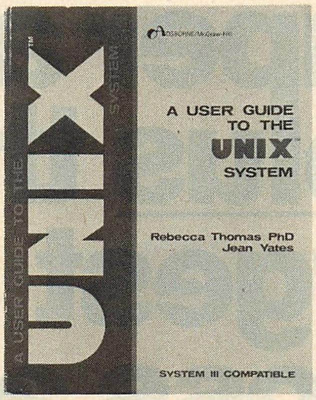
Other Factors

The foregoing exploration of data models points out the highlights of each model. A more detailed explanation appears in *Micro Database Development* (R. H. Bonczek, et al., Academic Press, 1984). An understanding of the various data models available is important when choosing a DBMS for the PC.

Aside from the data model, there are other important factors that should be considered. How does the DBMS guarantee the integrity of both data values and data interrelationships? How extensive are the DBMS transaction logging and warm restart capabilities? What data (and relationship) security mechanisms are built into the DBMS? With which programming languages can the DBMS data manipulation language be used? How extensive are the performance control facilities provided to a developer—for example, can the developer control physical structuring within a data base? Are multiple concurrent data base users handled with physical file lockouts or with more refined, sophisticated locking mechanisms?

Professional application systems developers for the PC should expect mainframe quality from PC-based data base management systems.

These are examples of issues that a mainframe DBMS normally is expected to handle satisfactorily. Professional application systems developers for the PC should expect the same of PC-based DBMSs.



Pascal for the IBM PC
Kevin W. Bowyer and Sherryl J. Tomboulian
Brady Company; Bowie, MD; 1983
323 pages, paper, $17.95

This book departs from earlier texts by looking at two specific Pascal compilers for the PC: Microsoft's MS Pascal and the UCSD p-System Pascal. It covers many (but not all) of the extensions that have been added to the compilers to make them more usable.

Pascal for the IBM PC begins with a look at the PC, its operating system, and its peripherals. Chapter 2, "Getting Started in Pascal," introduces the fundamentals of a Pascal program: BEGIN/END, numeric values, assignments, statements, READLN/WRITELN.

All of the simple data types and strings are introduced in Chapter 3 with details on how strings are handled by both of the Pascals covered. The next several chapters build on this foundation, always carefully calling out differences between IBM Pascal and the UCSD p-System Pascal.

Chapter 8, "Program Development," begins to touch upon how to put programs together to solve a problem. The method the authors discuss is a simplified version of Niklaus Wirth's method of programming by successive refinement, although it isn't referred to as such. This section and a discussion of some simple debugging techniques constitute the book's only treatments of programming *method*: otherwise the authors offer primarily a simple guided tour of the language.

Chapters 9 and 10 cover user-defined types and disk file I/O. Again, there is considerable variance between IBM Pascal and p-System Pascal, and the authors take pains to describe these differences in detail. The final chapter describes PC sound and graphics support through the UCSD p-System. IBM Pascal, with no easy way to handle sound or graphics, is not covered.

The overall slant of this book is toward the beginner, and from that perspective it does a fairly good job. With this book and one of the two compilers it covers, a novice can learn Pascal.

That's the good news. The bad news is that it won't help that novice become a *good* Pascal programmer.

The book's worst flaw is that it gives no discussion up front about structured methods, nor about why Pascal is laid out the way it is. Late in the book (far too late), a few pages are given to programming by the method of successive refinement. This information should not be presented as an afterthought. Even if the student doesn't fully understand structured methods at first, he must be aware of them from the beginning, before his fingers ever meet the keyboard.

A less serious flaw in the book is that the programming examples start out on an elementary level and stay that way. Programming examples have two purposes: to introduce new concepts and to provide well-written models for the reader to imitate. The examples in this book introduce new language features well enough, but there are no programs longer than 20 lines and none that does anything that could remotely be considered useful. A 20-line program that emulates two people discussing the weather (one of the examples actually used in the book) will teach the student nothing that will help him build a general ledger or an analysis of variance routine.

Pascal for the IBM PC succeeds admirably as a user's guide for parts of the two real-world Pascal compilers it covers. But user's guides are not enough, at least for Pascal: there is a method to thinking in Pascal that this book does not even begin to explore. I imagine many people who learn Pascal this way may end up dropping Pascal entirely, thinking of it as just a grouchy dialect of BASIC. The language and the students deserve better than that.

—JEFF DUNTEMANN

Games, Graphics, and Sound for the IBM PC
Dorothy Strickland, Dennis Rockwell, and Kevin Bowyer
Brady Company; Bowie, MD; 1983
259 pages, paper, $17.95

There are only two prerequisites for a thorough enjoyment of this technically accurate and well-written text: imagination and an elementary understanding of programming. The book's step-by-step guide to using graphics and sound, as well as its more than 70 examples, will excite and challenge everyone from the novice to the expert.

The text includes examples in BASIC, DOS Pascal, p-System Pascal, DOS FORTRAN, p-System FORTRAN, and DOS MACRO ASSEMBLER, a variety that adds greatly to the book's usefulness. In addition, the well-written, self-documenting code used in these examples could serve as a model for the beginning programmer.

Strickland, Rockwell, and Bowyer have chosen to describe and explain each new concept using the following format: they provide the name of the command, its purpose, the version of DOS in which the command operates, and a coded example.

The text is divided into four sections: chapter 1 is an introduction, chapter 2 discusses sound, chapter 3 covers graphics, and chapter 4 discusses animation. Three appendices are also included: one on sound and graphics routines (written in assembly language), another entitled "Internal Display and Storage Details," and a third, called "COLORON and COLOROFF," that in-

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Linker features:
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Instant Z-8000 Software! This package allows development and conversion of software for the Z8001, 8002, 8003 and 8004 based machines on a Z-80, Z-8000 or 8086 machine. This powerful package includes:
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- a 100 page User Manual
- a Zilog Z-8000 Technical Reference Manual

The Translators provide Z-8000 source code from Intel 8080 or Zilog Z-80 source code. This source code expansion is from 2% to 11%. The Translator outputs a worksheet and a Z-8000 source file. The worksheets show each line of 8080 Z-80 code, with notes to help th programmer to optimize performance, and further lower code expansion. It even comments lines it adds! The Z-8000 source code used by these packages are the unique 2500AD syntax using Zilog mnemonics, designed to make the transition from Z-80 code writing to Z-8000 easy.

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Powerful Macro Section—handles string comparisons during parameter substitutions. Recursion and nesting limited only by the amount of disk storage available.
Conditional Assembly—allows up to 248 levels of nesting.
Assembly Time Calculator—will perform calculations with up to 16 pending operands, using 16 or 32 Bit arithmetic (32 Bit only for 16 Bit products). The algebraic hierarchy may be changed through the use of parentheses

cludes code that facilitates switching between monitors.

Chapter 1 properly informs the reader that, "graphics can be used for more than games, since visual images and sound are a useful, and often pleasing way to present information." The authors also remind the reader that in order for the programs presented in chapters 3 and 4 to execute, the system used must contain a color/graphics adapter and a graphics display. Some time is spent on choosing a display.

Chapter 2 discusses BASIC's BEEP, PLAY, and SOUND commands and Pascal and FORTRAN's NOTE and TONE commands. The text points out that the PC is capable of producing a broader range of frequencies than can be reproduced on the PC's speaker.

Chapter 3 begins by explaining the differences between the medium- and high-resolution screens, different painting palettes, and disk-storage requirements for graphic images. The BASIC commands discussed are broken down into four groups: commands to prepare the screen for graphics; commands actually to draw the graphics; commands for storage and retrieval; and commands for control of user input. In keeping with the text's format, this section is followed by functionally equivalent commands used in several Pascal and FORTRAN programs.

Chapter 4 describes in detail the intricacies of animation. Many useful ideas are given as to how properly to select a graphic symbol. Other topics include methods of motion, keeping track of multiple images, speed of movement, and image interception. Each concept is followed by excellent examples in the above-mentioned languages.

Appendix A will be of particular interest to the Pascal or FORTRAN graphics enthusiast who hasn't yet purchased a graphics software package. Here the authors have included the assembly language listing for all of the Pascal and FORTRAN commands discussed in the text. The only thing the reader will have to do is copy and assemble them on the Macro Assembler. The text includes excellent step-by-step instructions on how to link the assembly language programs.

This is an excellent introductory text to the graphics and sound capabilities of the IBM PC. All of the commands are described clearly and illustrated with useful coded examples. Although subjects such as 3D rotation and translation, perspective, hidden line removal, and shading are not discussed, they are beyond the text's purpose.

To quote the authors, "An essential ingredient to creating good sound and graphics on your computer is knowing your computer's tools. You must then develop that rare blend of artistic sense, a feel for human desires, and an intuition for combining sounds and images imaginatively. We will describe the tools available on the PC and give you some tips for getting started, but putting it all together to create the magic of graphics with sound must come from you."

—CHRIS PAPPAS

A User Guide to the UNIX System

Rebecca Thomas and Jean Yates (Osborne/McGraw Hill; Berkeley, CA; 1982)

508 pages, paper, $17.95

Those of us who were around in the prehistoric days of 8-bit microcomputers remember when Adam Osborne's books were the only source of information outside of manufacturers' data sheets. Reading one of Osborne's books was like opening a Christmas present: after getting the package

unwrapped, you dug through layers of filler looking, sometimes in vain, for the hoped-for tidbit. (The books were printed on tissue paper, which only added to the illusion of a search through wrappings.) When McGraw-Hill bought the Osborne name for its computer-book business, we assumed that the frustrating searches were over. If *A User Guide to the UNIX System* is any indication, we were wrong.

The authors don't seem to know what kind of book they're writing or for whom they are writing it. Although it is introduced as being excellent for people with no computer experience, the book never offers more than a cursory explanation of many critical concepts (*directory*, for instance, is finally introduced on page 63, in four lines of text meaningful only to a UNIX system programmer). The first two chapters, "A History of the UNIX System" and "Computer Systems and Operating Systems," are generic self-parodies of the sort usually reserved for the annual reports of computer companies, including photos of Bell Labs scientists earnestly regarding pieces of unrecognizable hardware and an airbrushed photo of a business-suited quartet posed in front of an Amdahl 470; the latter photo is captioned, "A mainframe computer." Batch systems, we are told, can run only one program at a time.

All this is a shame, because hiding somewhere in this forest of superfluous information is a nice tutorial introduction to the system. Chapter three, "Tutorials," and chapter four, "Commonly Used UNIX System Commands" (which is just an extended tutorial), could be a helpful introduction for the UNIX beginner and a good review for the more experienced user.

Even these chapters are marred, though, by misprints and typographical errors. One section, devoted to demonstrating how many ways there are to destroy data under UNIX, contains an erroneous instruction that, if followed, will cause the reader to destroy the original copy of his file. Particularly galling to anyone who has used UNIX will be the capitalization of command names appearing at the beginning of sentences. UNIX is sensitive to case, and attempting to run "Ed" instead of "ed" will confuse the unsuspecting reader.

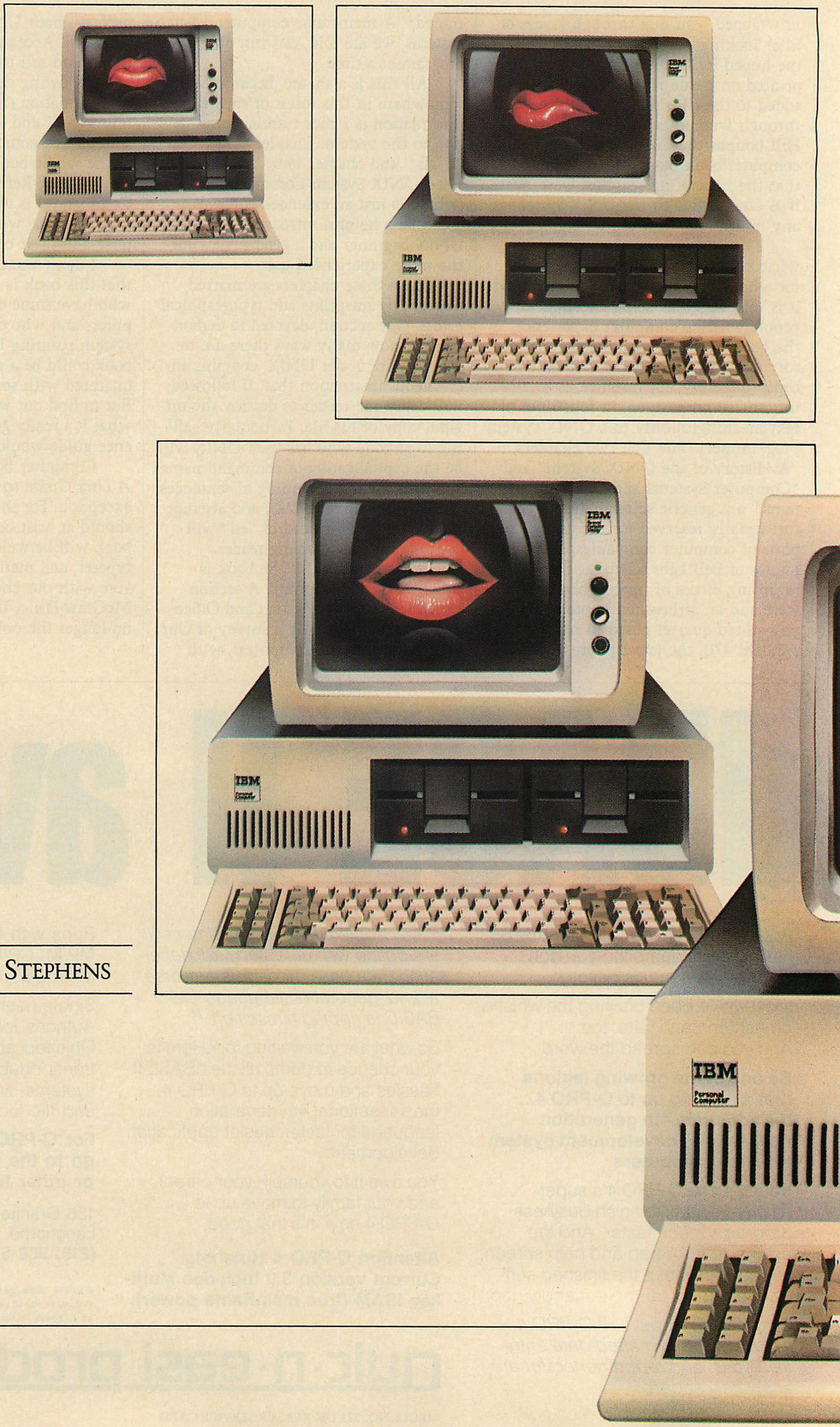
The remainder of the book is much like the beginning. A section called "The UNIX System and Office Automation" is mostly a survey of Our Glorious Future in Computers, with puffery about UNIX thrown in. "Evaluating and Accessing the System" is more hard sell than education.

Following that are several sections of information (not all accurate) on who sells UNIX and UNIX-capable hardware. Then comes the most useful part of the whole book—the bibliography. The "Quick Reference to UNIX System Commands" is too brief for an operating system in which commands are terse and their options even more so.

I don't want to give the impression that this book is a total loss. For users who have some experience with computers and who own or have access to a system running UNIX, reading this book could be a good way to become acquainted with some of UNIX's features. But to find out what UNIX really is or what it's really good for, a good reference guide would be a better choice.

Computer books are expensive, and *A User Guide to the UNIX System* is no exception. For the money we pay, we should at least be able to expect that a book will be well organized, carefully typeset, and meticulously edited. If we vote with our checkbooks, perhaps McGraw-Hill will see that Osborne is no longer the only game in town.

—Daniel M. Frank



JESSIE GUNN STEPHENS

MAKING YOUR SCREENS SPEAK FOR THEMSELVES

Tips on writing on-screen user messages

ILLUSTRATION • BOB AIESE

IN EACH FIELD, ENTER THE INFORMATION FOLLOWED BY RETURN. TO CORRECT MISTAKES, PRESS THE LEFT ARROW KEY TO ERASE THE PREVIOUS LETTER. IF YOU WANT TO FINISH ADDING RECORDS, PRESS RETURN WHEN ASKED FOR DATA.

The chances are that an experienced computer user could follow these on-screen instructions, after puzzling over them for a moment or two. Eventually, he would figure out that "finish" has to mean "stop." Someone who had never used a computer program before might not make that intuitive leap, however, and the program could end up gathering dust on the shelf.

Writing on-screen user messages presents some unique language problems. If a programmer wants users to understand his screen messages, he must think of words as packets of power, each as significant in a sentence as a variable is in a line of code. But words are trickier than coding symbols: they may not mean what the programmer thinks they mean, they may have several meanings, and their meaning may change according to the words used with them.

In the process of choosing the right phrasings, a programmer may find himself forced to use more words than he wants to. As the programmer sees the words piling up in his code, he may be tempted to take short cuts. The result can be a message as uncommunicative as the one that follows:

Jessie Gunn Stephens is a freelance writer in Sherman, TX. Her work has appeared in numerous computer-related magazines.

AFTER EACH ITEM I WILL ASK IF YOU WANT IT CHANGED. IF NOT, I WILL READ IN THE NEXT ITEM. IF YOU DO WANT IT CHANGED, THE CURSOR WILL BE DISPLAYED AT THE BEGINNING OF THE DATA.

The programmer who writes messages like this practices poor economy. In the course of shortening the message, he forgot to tell the user what action to take! But by using a few more, carefully chosen words, a programmer can write messages that inform users precisely how to control what is going to happen on their screens:

AFTER EACH RECORD IS DISPLAYED, I WILL ASK IF YOU WANT IT CHANGED. IF YOU DO NOT, PRESS "N" TO READ IN THE NEXT RECORD. IF YOU DO WANT IT CHANGED, PRESS "Y" TO MOVE THE CURSOR TO THE BEGINNING OF THE FIELD.

Short cuts in communication frequently lead to garbled messages. Wordy programs and confusing messages can be avoided if the programmer takes care to choose specific words, words that have precise meanings and concrete applications.

REMEMBER—THEY'LL TAKE YOU LITERALLY

Many first-time computer users, because they are acutely aware of their ignorance and perhaps a little afraid of what they don't understand, become literal-minded when they sit down at the keyboard. They're likely to try to follow instructions as literally as possible.

I guess we've all heard the one about the man who kept getting error messages from a program because the user manual told him to "Type in COMMAND XX and then RETURN," and that's exactly what he typed in. The programmer can make life easier for his Customer Service representatives simply by remembering that users tend to take instructions literally.

AVOID VIOLENT LANGUAGE

The smartest programmer will avoid wording messages in the violent terms that are common in computer jargon. Words like *fatal, aborted, crashed,* and even *error* itself have unpleasant connotations for most people. Why would anyone want such connotations associated with his product? Instead of these terms, a programmer should choose words that describe what is happening without making users think of death and destruction and failure. They have enough problems already without being made to feel that they have contributed to, or at least participated in, some violent act. Remember to instruct users to "press," rather than "hit" a key.

One simple rule regulates the amount of screen data an operator should have to deal with at any one time: Less is better.

TIE IN WITH THE MANUAL

Messages should be recorded in the user's manual exactly as they will appear on the screen. When people who are not highly computer-literate use an unfamiliar program, they need to feel that someone, somewhere, knew what was going on, since they themselves do not. A screen message that varies only slightly from what the manual said to expect may confuse users.

So, when designing and coding screen messages, write them into the notes from which the manual will be written, making sure they appear exactly as they'll appear on the screen. Not more or less the way they will appear, but exactly.

When coding error messages, note what conditions cause the errors (what the user may be doing wrong) and what can be done to recover from them. These messages, too, should be noted and included in the manual exactly as they appear on the screen.

WORK IN REASONABLE UNITS

One simple rule regulates the amount of screen data an operator should have to deal with at any one time: Less is better.

Screens filled from top to bottom are confusing, even threatening, especially if some parts of the display are flashing, honking, or otherwise showing off. Operators don't know where to look first. It's much more effective to break the display up into two or more screens and show them in a logical order than to ask users to deal with a whole screen full of instructions that they will need to remember.

Menus should contain only those options actually needed at any one moment. A preliminary study of user needs and expectations will help the programmer plan menus that make sense in these terms.

KEEP THE READER ORIENTED

On-line documentation should be designed in such a way that users know pretty much where they are within the program at any one time and how to get from there to somewhere else. Menus should allow them not only to choose an option within a particular segment of the program but also to go to other menus within the program and to exit the program.

Titles are among the best orientation devices. Put a title on every menu, every page of instruction. Use headings and subheadings to break up text and direct the reader's attention to what it is he's reading and why. Never break up a sentence between two screens. Make it possible to skip over instructional or other introductory material as soon

as it's no longer needed. Keep input requirements as simple and logically organized as possible. Provide fail-safe mechanisms to take care of misdirected commands before they can wipe out valuable data.

Keep users oriented to the importance of what they're doing by repeating and asking them to verify their choices of any options that will drastically alter a data base. In other words, make sure that operators really want to use the option they've selected, when that option could have a drastic and undesirable effect on their data. Following are examples of fail-safe messages:

YOU HAVE SELECTED THE OPTION TO DELETE FILE XXX ENTIRELY. IS THIS WHAT YOU WANT TO DO?

THIS COMMAND WILL CHANGE AMOUNT OWED. PLEASE VERIFY CUSTOMER NAME.

THE ACCOUNT NUMBER YOU HAVE ENTERED IS THAT OF JOHN Q. SMITH. IS THIS THE CORRECT ACCOUNT TO ALTER?

A programmer should alert users that what they are about to do will have an irrevocable effect on their files. Such thoughtfulness will save users money and headaches, making them feel friendlier toward software developers and their products.

Be Consistent

Have you ever wasted hours deep in the intricacies of someone else's code, hot on the trail of a maddeningly elusive bug, only to discover at last that the programmer used a single variable name for two different variables? If you felt like committing murder then, you have an idea of the problems that the lack of consistency can raise.

Give users a break. Allow them to engage their brains' habit-forming abilities in using the program. Let them build up trust in the program. Just "do the same old thing all the time," or at least as much of the time as possible. In other words, be consistent. If "Control-E" is used to mean "Exit" in one part of the program, don't use it to mean "Go to the next entry" in another. Let users transfer experience gained in one instance to as many other instances as possible.

If instructions, prompts, or messages appear habitually in about the

If "Control-E" is used to mean "Exit" in one part of the program, then don't use it to mean "Go to the next entry" in another. Let users transfer experience gained in one instance to as many other instances as possible.

same place on each screen, users will know automatically to check for them there, which will help them use the program more efficiently. Similarly, if they're accustomed to seeing a caution or warning outlined in asterisks, avoid using plus signs, exclamation points, or whatever as outlines; otherwise the warning may never make it past the barrier of expectation.

Many of us learned in school that using the same word over and over to mean the same thing is not an esthetically pleasing practice. Forget it. Documentation is not literature. Use the same word, and be sure it means the same thing every time it is used. Don't instruct the user to "Type X" one time and "Enter X" the next (especially not when what is really meant is "Type X and press Enter.")

Provide Feedback

Users always need to see that the computer is responding in some

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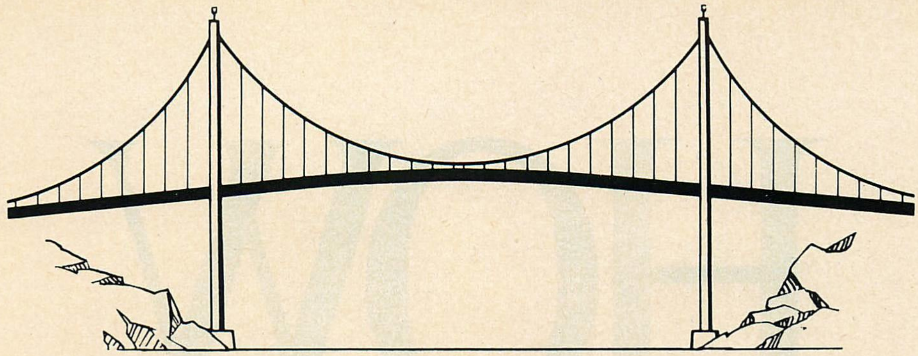
manner to the action they're taking or have just taken. Immediate response is a plus in making the user feel comfortable with the program. The message needn't be complex; all it needs to do is inform operators that they're not being ignored.

Feedback implies showing data on the screen as users type it in, always responding immediately to a user action, and providing warnings against undesirable action.

In addition, the message that advises users that they've just goofed should also tell them what to do next. A message that says only that something is wrong is next to useless for computer novices.

Feedback also implies *useful* information. Nowhere is usefulness more important than in error messages. Of course, the program should be designed to detect user errors as early as possible and to provide some means for dealing with illegal input. In addition, the message that advises users that they've just goofed should also tell them what to do next. A message that says only that something is wrong is next to useless for computer novices.

Take the time, too, to provide some device that will prevent screens from being entirely blank for more than a few seconds. Maybe an experienced user wouldn't reboot a program just because the screen went blank and silent after he gave a command, but many inexperienced people would, especially if they are already confused and not terribly certain of what's going on. So, provide some hint that the system hasn't died whenever there's the slightest possibility of doubt. Something like "One moment, please," for example. Whenever pos-



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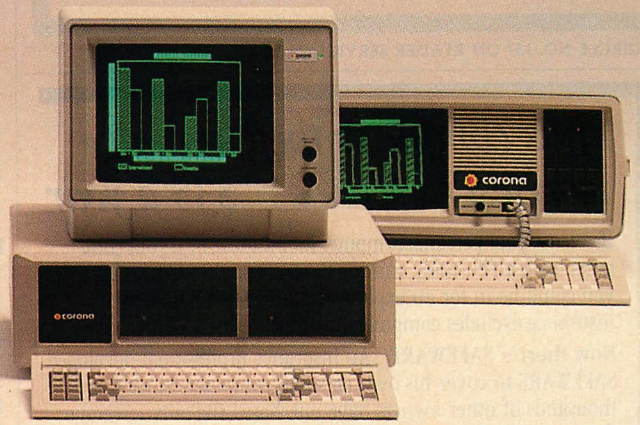

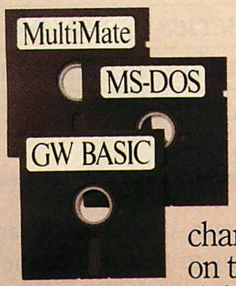

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sible, operators should receive immediate feedback in response to every action taken in the program.

Use Menus

Communicate with users via menus as frequently as possible. In general, it is best to avoid a series of Yes/No responses when all the viable options could be presented in menu form. Menus offer either actions or objects. They should always be titled so that operators understand the meaning of the options offered.

The best phrasing for action menus is usually verb/object: "PRINT DOCUMENT"; "LOAD FILE"; "GO TO XX MENU."

Menus offering a choice among objects, such as files, should be arranged in some conventional, easily recognizable order, such as alphabetically or by frequency of use. Whatever convention is chosen should be used for all menus.

The Screen Should Speak for Itself

Screen messages can be made to communicate clearly and effectively. When designing an inter-

Communicate with users via menus as frequently as possible. In general, it is best to avoid a series of Yes/No responses when all the viable options could be presented in menu form.

active program, devote some care and planning to that part of the package with which the users are most intimately involved—the instructions, prompts, messages, and menus that guide them through it. Screens that speak for themselves make a program easier for users to learn and developers to market.

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STRUCTURED B·A·S·I·C PROGRAMS

A User Command Language and Structured BASIC: How They Relate

My first program was written in 1955. It was in machine language: No higher-level languages existed then. The machine was an IBM-650 and all its instructions and data had to be ten-digit numbers. The machine had 2000 four-digit addresses.

Since then I have written hundreds of programs in FORTRAN, APT (a reversed Polish notation language), BASIC, APL, ALGOL, and COBOL, most of the large ones in FORTRAN and BASIC.

Why BASIC? Several reasons:

—It is a higher-level language and also an editor and an operating system. Its editing commands include LIST, DELETE, RENUM, and others. Its operating-system commands include LOAD (or OLD), SAVE, KILL (or UNSAVE), FILES (or CATALOGUE), and others.

—It is suited for both scientific computations and data base management. Practically all mathematical functions and the most intricate string and file management needs can be programmed in BASIC.

—It is relatively easy to debug. During program development, there is no need to use an editor or to compile. Line numbers make it easy to point to syntax errors. The PRINT and STOP statements allow easy tracing of program execution, even without such commands as TRON and TROFF.

—It is friendly. It places a minimum number of constraints on the programmer—variables don't have to be declared, certain arrays don't have to be dimensioned, strings are dynamic, file handling is flexible, and so on.

—It can be compiled. In the past, BASIC could only be interpreted and was therefore slow when used for certain applications. But now, at last, it can be both interpreted and compiled.

I believe that the day will come when users will want the source code of many of their application programs so that they may correct errors and modify the programs for their specific needs. BASIC is ideal for this.

—It runs on more than two million computers. I find it relatively easy to implement most of my BASIC programs on any computer. Although there are many versions of BASIC today, the problem of converting a program in one version of BASIC to another is really not too difficult, especially if the program is well-structured and documented.

—It is easy to modify. My experience shows that a useful program never remains unchanged, and it is easy to modify BASIC programs. I believe that the day will come when users will want the source code of many of their application programs so that they may correct errors and modify the programs for their specific needs. BASIC is ideal for this kind of modification.

A User Command Language Leads to Structure

In an earlier article ("UCL: A User Command Language," *PC Tech Journal*, Nov/Dec, 1983) I suggested that a standard user command language (UCL) be adopted by the computing community. Here I propose to show how such a language relates to structured BASIC programs. I hope an accepted standard for such structures can be set up.

First, let me review the principal commands in UCL:

COMPUTE—Carry out computing tasks. This command may have qualifiers (such as COM/MUL for multiplication) or may be replaced by several other commands (such as FIND, MIN, MAX, PLAY, QUIZ, and SIMULATE).

DISPLAY—Display on the screen or print into a file the current values of designated data. This includes data read from DATA statements (or from a file) and the results of computations.

EXAMPLE—Give examples of the precise format of the designated command. The purpose of the command is to remind the user about the format of a specific command by providing examples.

GET—Get data from the DATA statements of the program or from a designated file. My experience has shown that most programs use numerical and/or character data.

HELP—Give brief information on the designated topic. This command is usually for the infrequent user. For example, the command HELP COMMANDS lists all the available commands; HELP ALL lists all the available help messages.

NEW—Prompt the user for new data or for changes in designated portions of the current data. This command allows the user to change data without having to stop the program.

SAVE—Save the current data in a designated file. This command supplements the command NEW. It is useful when the user inputs a lot of data or when results are needed for future use.

STOP—Stop the running of the program. Although the running of most programs may be terminated by using special keys, it is a good idea to use such a command. Open files can then be closed and, if so coded, another designated program can be run.

Structure can be introduced into a program by coding the commands in specific line numbers. In most of my first programs line numbers were used haphazardly—100 here and a 257 there. Frequently, I found the need for inserting statements in a range of lines that could not hold them—and I would then use unnecessary GOTOs or GOSUBs. I'm sure that many BASIC programmers still follow this pattern. I no longer do.

The following framework seems to meet the needs of all my programs, small and large:

Commands and Routines	Block(s)
Preliminaries and constants	100
Command, HELP, and EXAMPLE	1000
GET, SAVE, NEW, and DISPLAY	2000
COMPUTE and/or other major commands	3000,4000,5000
Subroutines	6000,7000,8000,9000
DATA statements	9900
STOP and run another program	9999

In this framework, block XXX means a group of line numbers starting with XXX. Most of the blocks in my programs have the format XXOO, in analogy to city blocks and telephone numbers of institutional exchanges.

Block 100 is used for such preliminaries as dimension statements and assigning values to constants. This block is executed only once. In block 1000 the user is prompted for a command, and the command is interpreted and executed. Block 2000 is devoted to reading, changing, displaying, and saving of data.

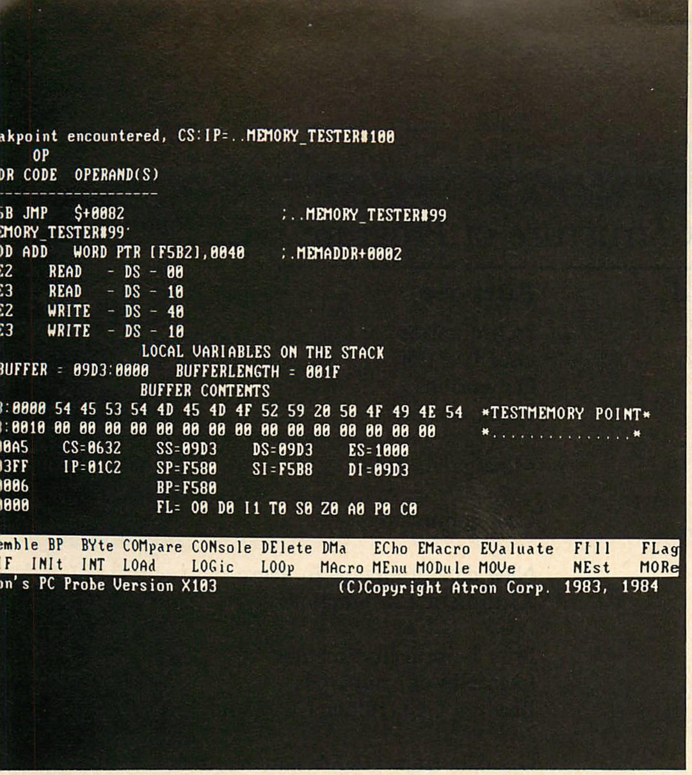

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Table 1 Block Structure of Program UCL.BAS

Block	Command	Purpose
100		Preliminaries
200		User function
300		Dimensions
400		String constants
900		Message via M$
1000		User command
1200	NEW	New data or change in data
1300	COMPUTE	Arithmetic computations
1700	HELP	Brief helpful information
1800	EXAMPLE	Examples of commands
1850		Reading UCLHEL or UCLEXA
2000	GET X	Get data from DATA statements
2050	GET file.ext	Get data from file.ext
2070	SAVE	Save data set
2100	NEW ELEMENT	Prompt for new value(s) of element(s)
2200	NEW ROW	Prompt for new values of row(s)
2300	NEW COLUMN	Prompt for new values of column(s)
2400	NEW ALL	Prompt for values in a new data set
2500	NEW ROW or ALL	Prompt routine
2600	NEW FORMAT	Change format
2700	DISPLAY	Display value(s) of data
3100	COM/xxx ROW	Do type xxx computations on rows
3200	COM/xxx COLUMN	Do type xxx computations on columns
3900		Arithmetic operations
9300		Zeroing of row 0 and column 0
9400		Qualifier extraction
9500		Range values
9600		Command parsing
9700		Panel, date, and time
9800		Error routine
9900		DATA statements
9999	STOP	Terminate running or chain

The major work of computing is done in blocks 3000, 4000, and 5000. Programs that require more space are too large and should be broken into smaller programs that chain together. After executing the commands in blocks 1000 to 5000, the program resumes execution in block 1000.

Blocks 6000 to 9000 contain subroutines that may be called from any of the blocks from 100 to 9000. The DATA statements are in block 9900, and the program terminates in 9999. I find it confusing to use line numbers larger than 9999.

The Structure of Program UCL.BAS

Program UCL.BAS will illustrate the use of the framework just outlined. This program is discussed in the aforementioned article, in which numerous outputs are given.

The framework in table 1 gives the general structure of program UCL.BAS. Tables 2 and 3 list all the variables in the program, and listing 1 gives one of the files read by the program. The actual coding of the program is in listings 2-7.

In order to conserve space, some of the blocks shown in ta-

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ble 1 are not included in the actual coding of listings 2-7. The coding of block 1800 is similar to that of 1700, blocks 2100 and 2300 are similar to 2200, and 3200 is similar to 3100. The relevant text of listing 1 is used in conjunction with the command HELP. A similar figure for the command EXAMPLE is not shown.

The remarks that follow give additional information on the structure of table 1 and the coding in listings 2-7. They also include information on routines that are not present in the UCL.BAS program but that are often used in user command language programs.

Block 100—The beginning of the program. Lines 1-99 are used in some programs for special code which must precede executable statements. Block 100 includes the name of the program, its most recent version, a few remark statements, and the ON ERROR GOTO statement.

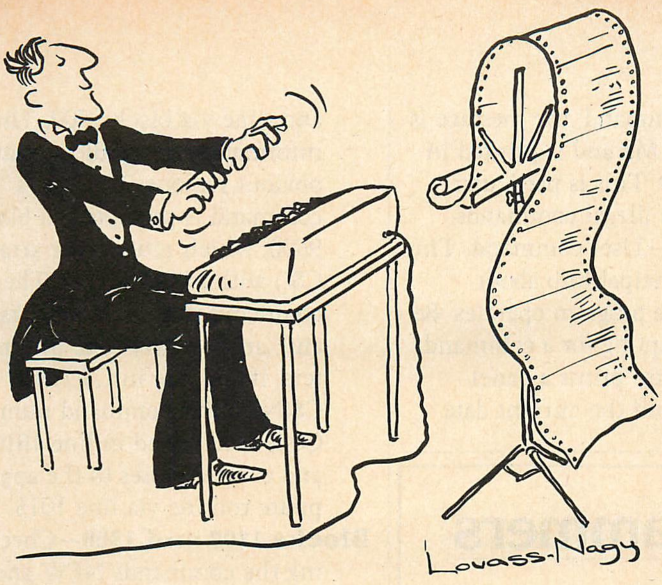
Block 200—User defined functions. In my opinion the number of such functions should be minimal. Whenever possible, subroutines should be used instead of user functions.

Block 300—Dimension statements. This block may also include the assignment of values to the variables that show certain maximum dimensions (M9 and N9 in UCL.BAS).

Blocks 400 and 500—String and number constants. Only variables that remain constant and those used as defaults are initialized in these blocks. The abbreviated command roots are in C0$, the qualifiers are in Q0$, and the parameters are in P0$.

Block 600—String headings and formats for PRINT USING. In most of my programs the variables Hi$ are used as headers, and the corresponding Ii$ as image formats.

Blocks 700 and 800—Special initializations. These include opening of files, reading con-



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stants from files, and reading strings passed on from chaining programs.

Block 900—Printing of a short message via M$. After executing most commands, the user is prompted for a new command in block 1000. However, whenever a short message must be displayed before prompting for a new command, the message is placed in M$ and is printed in block 900. This is particularly useful for illegal commands.

Block 1000—User command. This is the principal hub about which the program operates. Before prompting for a command, the program prints a panel number and the current date and time via block 9700. This information is useful for many obvious reasons. The user's command is prompted in block 9600, which returns the array C$() with N8 elements. The command root and qualifiers, if any, are in C$(1). The parameters, if any, are in C$(2) to C$(N8). The command number C0 is ascertained in line 1010, and control passes to the appropriate routine via line 1015.

Blocks 1200 and 1300—Checking the commands NEW and COMPUTE. The first parameter following the command NEW can only be one of the words in P0$ (line 415). The corresponding parameter number P0 is determined in 1200 and execution then continues via line 1210. Note that an illegal parameter leads to the printing of the message "Bad UCL" (lines 1005,1200,1205, and 900). A similar approach is used for the command COMPUTE, which needs one of the qualifiers in Q0$ of line 410. The qualifier Q0 is extracted from C$(1) in block 9400 and in line 1305. Note that the code in line 1300 includes a check for the required number of parameters, and the code in lines 1310-1315 includes a check for the word ROW or COL.

Blocks 1400 and 1500—Other commands checking. Just as block 1300 is used to check the qualifier and parameters for the command COMPUTE before branching to routines in block 3000, so do blocks 1400 and 1500 for other major commands before branching to the routines in blocks 4000 and 5000.

Blocks 1700, 1800, and 1850—The commands HELP and EXAMPLE. The texts for these commands are in files UCLHEL.ASC (listing 1) and UCLEXA.ASC (not shown). These files are structured as

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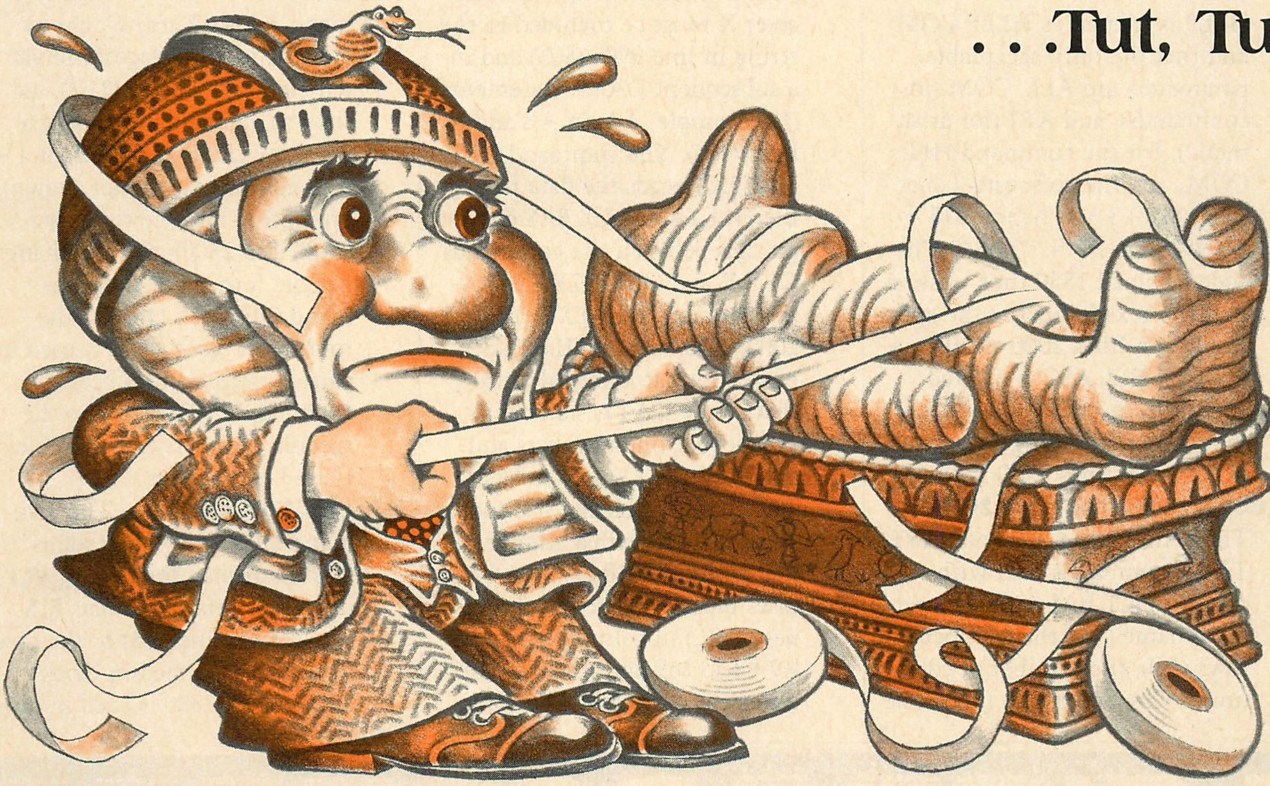

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BASIC programs and contain only remark statements. In this way they can be prepared and edited in BASIC. The code in lines 1700-1715 ensures that HELP is treated as HELP COM and that the only acceptable parameters are ALL, COM (for commands), and ARI (for arithmetic). For the command HEL COM, say, the code establishes that Q0 = 1 and hence T1$ = "1999" and T$ = "2999". The code in block 1850 then ensures that the text following the apostrophes in lines 2000 to 2030 in file UCLHEL.ASC is printed. The code in lines 1800-1815 (not shown in listing 3) is much like that in lines 1700-1715.

Blocks 2000,2050, and 2070—The commands GET and SAVE. These commands deal with data. In UCL.BAS each data set has a name (S$), the number of rows (R9), the number of columns (C9), and a title (V$). The data are in an array V(,) with rows 0 to R9 and columns 0 to C9. The command GET X reads the data in the DATA statements of block 9900. The character X must be included in the string in line 9905 (S0$) and in a subsequent DATA statement (for example, A is in AB and in line 9910). The command GET FILE.EXT reads the data from file FILE.EXT. UCL.BAS distinguishes between the commands GET X and GET FILE.EXT by the period in FILE.EXT (line 2000). The data in FILE.EXT have a format identical with that of the DATA statements, except that line numbers and the word DATA are omitted. The coding of block 2050 (not shown) is somewhat similar to that in lines 2010-2020. In both cases block 9300 zeroes the values of V(,) in column 0 of rows R9+1 to M9 and row 0 of columns C9+1 to N9. The command SAVE in block 2070 puts the data in a file in a format which GET FILE.EXT can subsequently read.

Blocks 2100 to 2600—The command NEW. These blocks are devoted to changing of individual elements in V(,) (2100, not shown), changing or adding a new row (2200 and 2500) or a new column (2300, not shown), prompting for a new data set (2400 and 2500), and for changing the format for the command DISPLAY (2600). The routine in block 9500 is used to parse a range of numbers (for example, ROWS 3-5) into the specific numbers (for example, G1=3 and G2=5).

Blocks 2700 to 2900—The command DISPLAY. The code is used to display the data in V(,) using the default formats F1$ and F2$ (of line 425) or the new formats established in block 2600. Block 2800 is used in pro-

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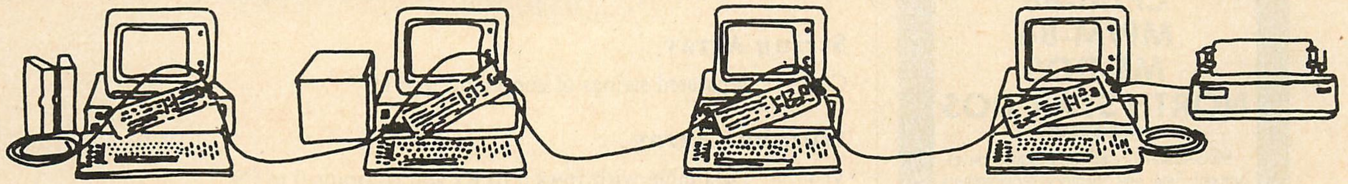

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Menu driven	Yes	No	Yes	Yes	Yes
Files open on line	8	2	N/A	2	1
Maximum records/file	100,000,000	65,600	32,800	32,800	32,800
Maximum bytes/record	10,000	1,000	2,400	1,000	255
User must be programmer	No	Yes	No	No	No
Maximum number of indexes automatically updated.	15	1	1	1	1

(Data are taken from most recent versions of programs available to American Planning Corporation, Alexandria, VA)

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Table 2 User Function, Arrays, and String Variables

User Function

FNS$	Number to string conversion (without a leading space)

String Array

C$()	Separated strings of command line L$

Number Array

V(,)	Data table with rows 0 to R9 and columns 0 to C9

String Variables

C$	First parameter [C$(2)]
C0$	Command roots
F0$	General format for PRINT USING
F1$	Initial format for non-integers
F2$	Initial format for integers
L$	Command line
M$	Message to user
P0$	Parameter words
Q0$	Qualifier words
Q1$	Quotation mark ["]
Q2$	Apostrophe [']
S$	Name of data set
S0$	Names of all sets in the DATA statements
S1$	Comma [,]
S2$	Space [ ]
T$	Temporary string
T1$	Smallest line number (for HELP or EXAMPLE)
T2$	Highest line number (for HELP or EXAMPLE)
V$	Title of data set
X$	Current separated string of L$

grams which have numerous data sets—it gives their names, sizes, titles, and other summary information. Block 2900 is used to list the contents of specified lines of designated ASCII files.

Blocks 3000 to 3900—The command COMPUTE. Here all the work associated with the command COMPUTE (or some other major command) is carried out. In UCL.BAS only blocks 3100, 3200, and 3900 are used. In advanced applications the coding present in these blocks can sometimes be extensive, utilizing the subroutines found in blocks 6000 to 9000.

Blocks 4000 and 5000—Other major commands. Depending on the application, there may be extensive coding here.

Blocks 6000 to 9000—The subroutines. Subroutines are placed in blocks 6000, 6050, . . . 9350.

Blocks 9400 to 9800—General purpose routines. Block 9400 is used to extract the qualifier from C$(1). This routine can be generalized for programs with several qualifiers. Block 9500 accepts a range of numbers in the format xx-yy (or just zz) and returns G1=xx and G2=yy (or G1=zz and G2=zz). It is used by the commands NEW and DISPLAY. The command parsing routine of block 9600 (not shown) accepts a string L$ and returns N8

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(the number of strings in L$) and the separated strings: C$(1), . . . C$(N8). Block 9700 updates the panel number (P7) and prints the current date and time. Block 9800 resolves errors directed to it via the ON ERROR GOTO statements throughout the program (in UCL.BAS there is only one such statement—line 199).

Block 9900—The DATA statements. In most of my programs all the DATA statements are in lines 9900-9998. Occasionally, it is necessary to deviate from this scheme. In UCL.BAS, data set A is placed in lines 9910-9914 and data set B is placed in lines 9920-9925 (not shown).

Block 9999—The command STOP. It is always a program's last line.

Notes on Variable Names and Documentation

Because I use short variable names, although the PC allows long variable names, many people will claim that I am not following accepted practices. I want to say a few words in defense of my approach. The topic is also related to the problem of documenting computer programs—and I intend to comment on this, too, in concluding the article.

I use short variable names for a number of reasons:

—In all my scientific training, only short variable names have been used. In algebra we use expressions such as A = 3*X + 2*Y but not A = 3*ROW + 2*COLUMN. And when I write $e = mc^2$, I'm sure everyone knows what I mean.

—The longer the name of the variable the higher the probability of making a typing error.

—It is easier for me to read statements with numerous key words when the variable names are short. The first version of BASIC had some 30 or so key words. The PC BASIC release 2.0 has 174, and more will be coming, no doubt.

—Longer variable names lead to longer statements. It is difficult to get certain statements into 80 columns even with short names. Longer names will make many statements difficult to read.

—Longer variable names greatly increase the size of a program. In UCL.BAS most variable names consist of two characters. If each variable name were increased by, say, three characters, the size of the program would be increased by about 1500 characters—or 25 percent.

*In all my scientific training, only short variable names have been used. In algebra we use expressions such as A = 3*X + 2*Y but not A = 3*ROW + 2*COLUMN. And when I write $e = mc^2$, I'm sure everyone knows what I mean.*

—During program development, I find that every variable is unambiguously recognizable. Just as I don't have any difficulty in identifying Tom (with whom I work), or FDR, or what is meant by the names APL and C, I don't have trouble recognizing C0$ and C0.

You might ask, "But what about another person who wants to read your program," or "Suppose you want to change an old program?" This, of course, is related to documentation—and I have some unorthodox ideas on this subject, too. I believe that there should be a distinction between submission of a program to the computer for execution and its documentation. The former should include very few remarks, while the latter should present the identical program in an easy to read format, and should include additional normal text. This kind of documentation can be ac-

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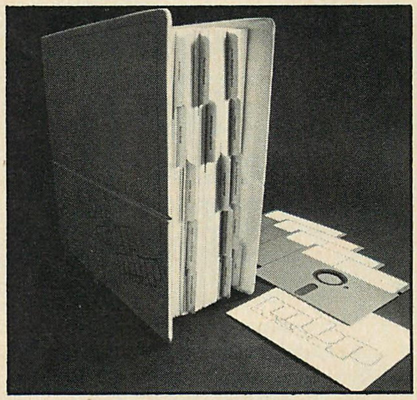

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Table 3 *Number Variables*

Number Variables	
C	Column
C0	Root number corresponding to the word in C0$
C1	First column
C2	Second or last column
C3	Third column
C9	Last column in V(,)
G1	First value of the range
G2	Last value of the range
J	Counter or pointer
M9	Largest possible C9
N	Number to be converted to a string (FNS$)
N8	Number of strings in C$()
N9	Largest possible R9
P	Pointer to next quote
P0	Parameter number corresponding to the word in P0$
P7	Panel number
Q0	Qualifier number corresponding to the word in Q0$
Q1	Location of first quote
Q2	Location of apostrophe
R	Row
R1	First row
R2	Second or last row
R3	Third row
R9	Last row in V(,)
S1	Location of first separator
S2	Location of the space character
V	Current value of V(,)
V1	Value of V(,) in first row (column)
V2	Value of V(,) in second row (column)
V3	Value of V(,) in third row (column)

complished if one places the additional text in a special file and uses a program that merges this special file with the original program.

This approach was used for preparing listings 2-7. The text was put in a file called UCL.DOC and a program called PAGER.BAS was used to merge the file with UCL.BAS. In general, when you use PAGER.BAS:

—The listing is separated into numbered pages.

—A header (from UCL.DOC) begins each block.

—When a program line contains several statements, they are displayed separately.

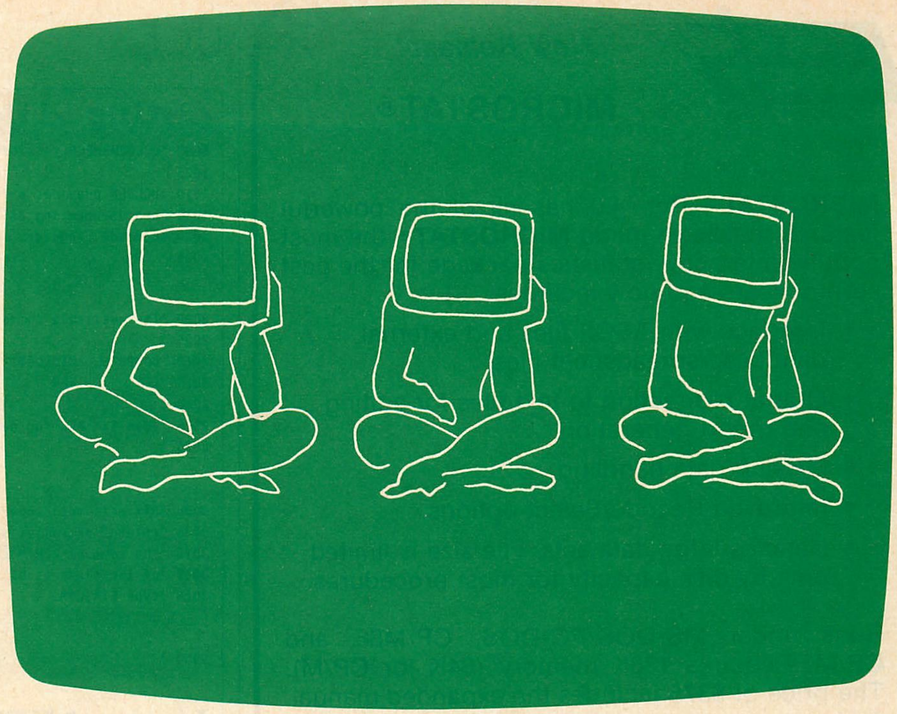
—When an ELSE clause is encountered, it is displayed separately.

—FOR . . . NEXT loops are marked. This allows one to see loops extending over several pages.

Normally, the major variables used in a program will be listed in the documenting file. The variables used in UCL.BAS are shown in tables 2 and 3—therefore, they were not included in UCL.DOC.

The documentation should also include sample runs, unless they can be obtained easily by running the program. The sample runs for UCL.BAS are in my previously cited article in this magazine. A complete documentation of a program will also include a cross reference table of all its variables, its key words, and referenced lines. Such a table was not included in this article in order to conserve space.

Eliezer Naddor, a professor of mathematical sciences at The Johns Hopkins University, has written articles in PC Tech Journal *on UCL and Sorting and Timing Methods for the PC.*



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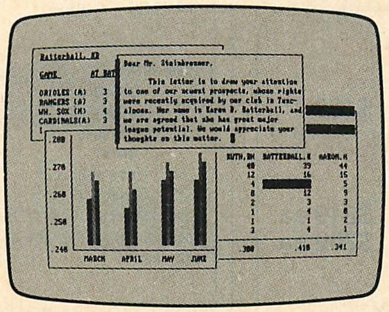

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Listing 1 File UCLHEL.ASC

```
                                                  HELP 1000
1000 'UCLDEM HELP version 83/05/13
1005 '
1010 'UCLDEM provides a framework for implementing, testing,
1015 'and documenting BASIC programs using UCL - the User's
1020 'Command Language.
1025 '
                                         HELP COMMANDS 2000
2000 'The available commands are:
2005 '
2010 'COMPUTE   DISPLAY   EXAMPLE   HELP
2015 'GET       NEW       SAVE      STOP
2020 '
2025 '(Use EXA ALL for detailed examples of all commands.)
2030 '
                                       HELP ARITHMETIC 3000
3000 'Six arithmetic operations may be performed on rows or
3005 'columns of values stored in an array V(,). For example,
3010 'the command COM/MUL ROW 1,3 6 places in row 6 the products
3015 'of the elements of rows 1 and 3. For additional examples
3016 'type EXA,COM.
                                                   END 9999
9999 '
```

Listing 2 UCL.BAS—Blocks 100, 200, 300, 400, 900, 1000, and 1200

```
100 PRINT "UCL.BAS version 83/05/22"
105 REM Copyright C 1983 by Eliezer Naddor
110 REM Needs UCLEXA.ASC and UCLHEL.ASC
115 REM UCL parsing algorithm in 9600
116 REM by David Naddor 83/04/26
199 ON ERROR GOTO 9800
                FUNCTION DEFINITION, NO LEADING SPACE 200
200 DEF FNS$(N)=MID$(STR$(N),2)
                                          DIMENSIONS 300
300 DIM C$(12),V(12,9)
     :M9=12
     :N9=9
                                    STRING CONSTANTS 400
400 REM    1   2   3   4   5   6   7   8
405 CO$=" COM DIS EXA GET HEL NEW SAV STO"
410 QO$=" ADD SUB MUL DIV MIN MAX COM ARI"
415 PO$=" ELE ROW COL ALL FOR"
420 CO$="   "+CO$
     :QO$="   "+QO$
     :PO$="   "+PO$
425 FO$="###,###.######"
     :F1$="####.##"
     :F2$="####   "
430 Q1$=CHR$(34)
     :Q2$="'"
     :S1$=","
     :S2$=" "
                                     MESSAGE VIA M$ 900
900 PRINT " ";M$
                                       UCL COMMAND 1000
1000 PRINT
     :GOSUB 9700
     :PRINT "UCL? ";
1005 GOSUB 9600
     :PRINT
     :M$="Bad UCL"
     :C$=C$(2)
1010 CO=INSTR(1,CO$," "+LEFT$(C$(1),3))/4
1015 ON 1+CO GOTO 900,1300,2700,1800,2000,1700,1200,2070,9999
1020 REM         UCL COM  DIS  EXA  GET  HEL  NEW  SAV  STO
                                        NEW (1015) 1200
1200 M$="Ready"
     :PO=INSTR(PO$," "+LEFT$(C$,3))/4
1205 ON 1+PO GOTO 900,2100,2200,2300,2400,2600
```

```
1210 REM          UCL ELE  ROW  COL  ALL  FOR
```

Listing 3 UCL.BAS—Blocks 1300, 1700, 1850, and 2000

COMPUTE (1015) 1300

```
1300 GOSUB 9400
     :IF J=0 OR N8<>5 THEN 900
1305 QO=INSTR(QO$," "+LEFT$(T$,3))/4
     :IF QO=0 OR QO>=7 THEN 900
1310 PO=INSTR(PO$," "+LEFT$(C$,3))/4
1315 IF PO<>2 AND PO<>3 THEN 900
      ELSE  M$="Done"
1320 ON PO-1 GOTO 3100,3200
1325 REM          ROW  COL
```

HELP (1015) 1700

```
1700 IF N8=1 THEN C$="COM"
      ELSE IF C$="ALL" THEN T1$=""
     :T2$="9998"
     :GOTO 1715
1705 QO=INSTR(QO$," "+LEFT$(C$,3))/4-6
     :IF QO<=0 THEN 900
1710 T1$=FNS$(1000*QO+999)
     :T2$=FNS$(1000*QO+1999)
1715 C$="UCLHEL.ASC"
     :GOTO 1850
```

READING UCLHEL OR UCLEXA 1850

```
1850 OPEN C$ FOR INPUT AS #1
1855 IF LEN(T1$)<=3 THEN T1$=""
1860 LINE INPUT #1,T$
     :IF T$<T1$ THEN 1860
1865 IF T$<T2$ THEN PRINT MID$(T$,7)
     :GOTO 1860
1870 CLOSE 1
     :GOTO 1000
```

GET (1015) 2000

```
2000 IF INSTR(C$,".")>0 THEN 2050
      ELSE RESTORE
2005 READ SO$
     :IF INSTR(SO$,C$)=0 THEN M$="No data set "+C$
     :GOTO 900
2010 READ S$,R9,C9,V$
     :FOR R=0 TO R9
2015 FOR C=0 TO C9
     :READ V(R,C)
     :NEXT C
2020 NEXT R
     :IF S$<>C$ THEN 2010
      ELSE GOSUB 9300
     :GOTO 2090
```

Listing 4 UCL.BAS—Blocks 2070, 2200, 2400, and 2500

SAVE FILE.EXT (1015) 2070

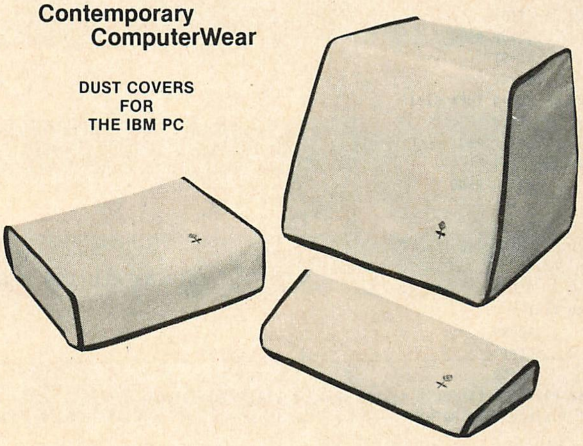
```
2070 IF INSTR(C$,".")=0 THEN 900
      ELSE OPEN C$ FOR OUTPUT AS #2
2075 WRITE #2,C$,R9,C9,V$
2080 FOR R=0 TO R9
     :FOR C=0 TO C9-1
     :PRINT #2,FNS$(V(R,C));",";
2085 NEXT C
     :PRINT #2,FNS$(V(R,C9))
     :NEXT R
     :CLOSE 2
2090 M$="Data set "+C$+" ready"
     :GOTO 900
```

NEW ROW (1205) 2200

```
2200 T$=C$(3)
     :GOSUB 9500
     :R1=G1
     :R2=G2
     :IF R2>R9 THEN R9=R2
2205 GOTO 2500
```

NEW ALL (1205) 2400

```
2400 PRINT "Set,Rows,Cols,Title";"? ";
2405 GOSUB 9600
```

```
        :IF N8<>4 THEN 2400
2410 S$=C$(1)
        :R9=VAL(C$(2))
        :C9=VAL(C$(3))
2415 V$=C$(4)
        :R1=1
        :R2=R9
        :GOSUB 9300
```

NEW ROW AND NEW ALL (2205) 2500

```
2500 FOR R=R1 TO R2
        :V(R,0)=1
2505 PRINT C9;"values in row";R;"? ";
2510 GOSUB 9600
        :IF N8<>C9 THEN 2505
2515 FOR C=1 TO C9
        :V(0,C)=1
        :V(R,C)=VAL(C$(C))
        :NEXT C
2520 NEXT R
        :GOTO 900
```

Listing 5 UCL.BAS—Blocks 2600, 2700, 2710, 2720, and 2740

NEW FORMAT (1205) 2600

```
2600 M$="Bad format"
        :C$=C$(3)
2605 IF INSTR(F0$,C$)=0 GOTO 900
         ELSE F1$=C$
        :F2$=C$
2610 J=INSTR(C$,".")
2615 IF J>0 THEN F2$=LEFT$(F1$,J-1)+SPACE$(LEN(F1$)-J+1)
2620 M$=F1$+" noted"
        :GOTO 900
```

DISPLAY (1015) 2700

```
2700 P0=INSTR(1,P0$," "+LEFT$(C$,3))/4
2704 ON 1+P0 GOTO 900,2710,2720,2730,2740,2770
2706 REM          UCL ELE  ROW  COL  ALL  FOR
```

DISPLAY ROW (2704) 2720

```
2720 T$=C$(3)
        :GOSUB 9500
        :R1=G1
        :R2=G2
2722 IF N8<=4 THEN C1=1
        :C2=C9
        :GOTO 2750
2724 T$=C$(5)
        :GOSUB 9500
        :C1=G1
        :C2=G2
        :GOTO 2750
```

DISPLAY ALL (2704) 2740

```
2740 R1=1
        :R2=R9
        :C1=1
        :C2=C9
2742 PRINT "Data set = ";S$;"  Rows =";R9;" Cols =";C9;
  " Title = ";V$:PRINT
```

Listing 6 UCL.BAS—Blocks 2750, 3100, and 3900

DISPLAY ROUTINE (2710, 2722, 2724, 2732, 2734) 2750

```
2750 IF R2>R9 OR C2>C9 THEN 900
         ELSE PRINT "   Col";
2752 FOR C=C1 TO C2
        :IF V(0,C)>0 THEN PRINT USING F2$;C;
2754 NEXT C
        :PRINT
        :PRINT "Row"
2756 FOR R=R1 TO R2
        :IF V(R,0)=0 THEN 2766
         ELSE PRINT USING "###    ";R;
2758 FOR C=C1 TO C2
        :IF V(0,C)=0 THEN 2764
2760 V=V(R,C)
        :IF V=INT(V) THEN T$=F2$
         ELSE T$=F1$
2762 PRINT USING T$;V;
2764 NEXT C
        :PRINT
2766 NEXT R
        :GOTO 1000
```

COMPUTE/xxx ROW (1320) 3100

```
3100 R1=VAL(C$(3))
        :R2=VAL(C$(4))
        :R3=VAL(C$(5))
3105 FOR C=1 TO C9
        :V1=V(R1,C)
        :V2=V(R2,C)
3110 GOSUB 3900
        :V(R3,C)=V3
        :NEXT C
        :V(R3,0)=1
3115 IF R3>R9 THEN R9=R3
3120 GOTO 900
```

ARITHMETIC OPERATIONS (3110, 3210) 3900

```
3900 ON Q0 GOTO 3910,3920,3930,3940,3950,3960
3902 REM         ADD  SUB  MUL  DIV  MAX  MIN
```

ADD (3900) 3910

```
3910 V3=V1+V2
        :RETURN
```

MUL (3900) 3930

```
3930 V3=V1*V2
        :RETURN
```

Listing 7 UCL.BAS—Blocks 9300, 9400, 9500, 9700, 9800, 9900, 9910, and 9999

ZERO V(R,0) AND V(0,C) (2020, 2065, 2415) 9300

```
9300 FOR R=R9+1 TO M9
        :V(R,0)=0
        :NEXT R
9305 FOR C=C9+1 TO N9
        :V(0,C)=0
        :NEXT C
        :RETURN
```

QUALIFIER (1300) 9400

```
9400 T$=C$(1)
        :J=INSTR(T$,"/")
9405 IF J>0 THEN T$=MID$(T$,J+1)
9410 RETURN
```

RANGE VALUES (2200, 2300, 2720, 2724, 2730, 2734) 9500

```
9500 J=INSTR(2,T$,"-")
9505 IF J=0 THEN G1=VAL(T$)
        :G2=G1
9510 IF J>0 THEN G1=VAL(LEFT$(T$,J-1))
        :G2=VAL(MID$(T$,J+1))
9515 RETURN
```

PANEL, DATE, AND TIME (1005) 9700

```
9700 P7=P7+1
        :PRINT "[";FNS$(P7);"] ";
9705 PRINT DATE$;" ";TIME$
        :RETURN
```

ERROR ROUTINE (199) 9800

```
9800 PRINT "ERR = ";ERR;"in line";ERL
9805 STOP
        :RESUME 1000
```

DATA (2010, 2015) 9900

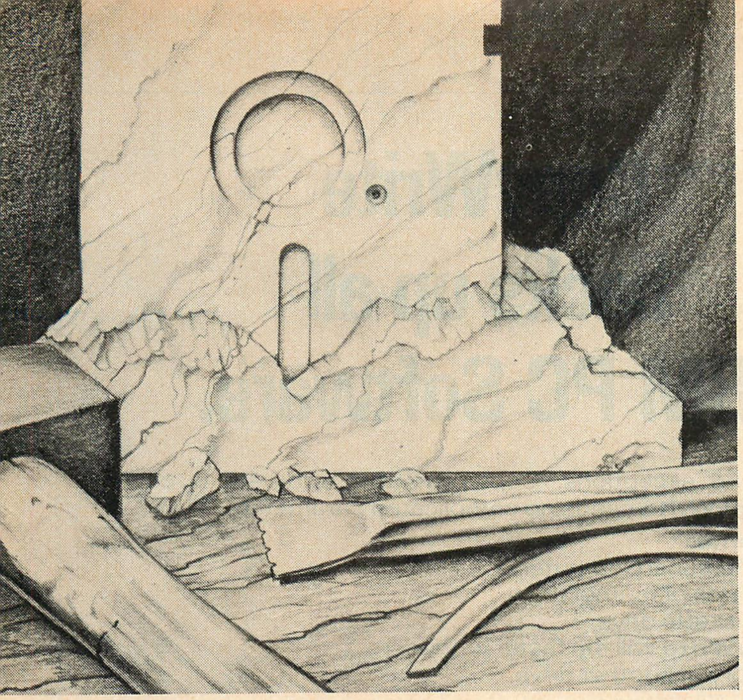
```
9900 REM S$=Set,R9=Rows,C9=Colms,V$=Title
9905 DATA AB
```

DATA SET A 9910

```
9910 DATA A,3,5,"Stores and items"
9911 DATA 1,  1, 1, 1, 0, 1
9912 DATA 1, 20,35,12,37,59
9913 DATA 1,  8,20, 4,42,60
9914 DATA 0, 22,33,18,27,49
```

STOP—CHAIN OR END (1015) 9999

```
9999 IF N8=2 THEN CHAIN C$
```



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Disputing the Rights to Custom-designed Software

Who has the rights depends on the state in which the work was done, the state in which the agreement was made, and, most importantly, the intent of the parties

MAX STUL OPPENHEIMER

Some subjects are simply not discussed in polite company. A recent article in *MIS Week* suggests that the ownership of rights in custom software is one of them. The article reported that several programmers at a seminar revealed that they were involved in litigation over programs they had developed as consultants.

In an article entitled "Caltech Torn by Dispute over Software" (May 27, 1983), *Science* reported on the results of a dispute involving the ownership of a computer program that was written by a member of the California Institute of Technology physics department: "A brilliant young physicist has resigned from Caltech, the computer program's development has been abandoned, and rifts have grown between administrators and faculty."

According to the *MIS Week* article, each "consultant had assumed that he was working with the company on an emerging technology and would be able to apply the learned solutions later on other jobs. However, the companies involved felt that the consultants were being paid for work performed for them, the product of which was the company's exclusively."

Unfortunately, as is often the case when both parties take rational positions, it is difficult to provide abstract answers regarding the outcome of their dispute. Under the copyright law, ownership of a work "made for hire" belongs to the employer. However, a "work made for hire" has a technical meaning that would not ordinarily apply to programs that were written by an independent consultant.

A more general legal doctrine known as *shop rights* provides that the product of an employee's labor done on his employer's time or using his employer's facilities will generally belong to the employer. Again, this doctrine will rarely apply to the independent consultant.

Who owns a custom-written program? It depends on the state in which the work was done, the state in which the agreement was made, and, most importantly, the intent of the parties. Readers of prior columns will recognize the words "intent of the parties" and may well be thinking that lawyers use that phrase when they don't have an answer. In a sense that is true—in many contract issues, the result is determined by what the judge believes the parties meant to do (or would have meant to do had they thought about the issue). In the absence of documentary evidence, the judge can consider industry practice, prior dealings between the parties, actions of the parties, and anything else he believes may be indicative of intent. In short, both parties are rolling dice.

This is one situation in which an ounce of documentation is worth a pound of proof. From a programmer's point of view, the right to improve, modify, and resell his program likely ranks with (if not above) the price he receives for the first sale, unless it is a highly specialized or confidential program. Likewise, the purchaser (unless he views the program as in some way confidential, or of such competitive value that he insists on keeping it solely in his own control) can be given an incentive to allow continued development and sale of the program, if he has the right to receive updates as the program is improved for other customers.

Why, then, does this crucial point remain unresolved? It is possible that the parties are unaware of the issue or underestimate its importance. It is also possible that the parties do not like to deal with conflict (although they invariably do so when negotiating zero-sum terms, such as price and delivery). The most likely explanation is that bargaining over dollars is intuitive—it is easy to measure progress and success in monetary negotiations—whereas many consultants and their customers cannot identify, much less place values on, the rights involved in ownership of software. Some of those rights are:

1. The right to sell or resell the software, "as is"
2. The right to use the software, "as is"
3. The right to license or sublicense the software, "as is"

4. The right to have control over the marketing of the software
5. The right to translate the software into other languages or adapt it for use on other machines
6. Each of the above rights with respect to future modifications of the software.

A contract to provide custom programming should address the question of rights. There is no absolutely correct resolution—it is a matter of bargaining power and persuasion. A programmer might open negotiations with the specification that "the customer shall have the right to use the program at his place of business for the specified purpose, but may not modify or copy it (except into the memory of the specified machines) and may not disclose it except to individuals who have signed an appropriate secrecy oath. The programmer shall have the copyright on the program as well as all rights to modify or resell it" (see the IBM Program License Agreement discussed in this column in the July-August 1983 issue of *PC Tech Journal*).

The customer might counter that offer with this: "The programmer hereby grants and assigns to the customer during the initial term of its copyright and all renewals and extensions thereof, all rights in the program as well as any improvements made to it, whether by customer or programmer. Programmer shall, without additional fee, disclose to customer any ideas for the modification, improvement, or use of the program, all of which shall become the property of customer. Programmer shall execute all documents and take such other steps as customer requests to confirm and protect customer's rights."

One possible compromise would be to place copyright ownership with one of the parties; the other party would be licensed to copy, modify, and use the program, with both parties having the right to market their own improvements. Another compromise would be to set up a royalty arrangement between the parties. Still another would be to divide the marketing areas, after due thought to potential anti-trust implications.

If a programmer or customer has absolutely no bargaining power, he might rationally decide not to raise the issue of rights in custom software. However, if neither party raises the issue, at least one of them has made a mistake.

Max Stul Oppenheimer is a contributing editor to this magazine and a partner in the law firm of Venable, Baetjer, and Howard in Baltimore.

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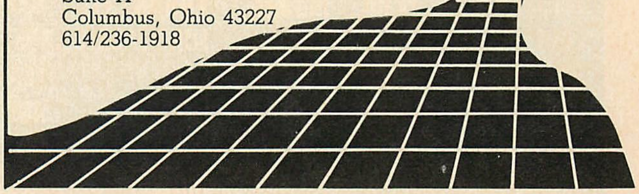

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The BASTOC single unit binary price is $350, and includes documentation, media, and shipping. To order, or to get more information, write or call JMI Software Consultants, Inc., 215-657-5660. Check, Money Orders, VISA and MC are acceptable.

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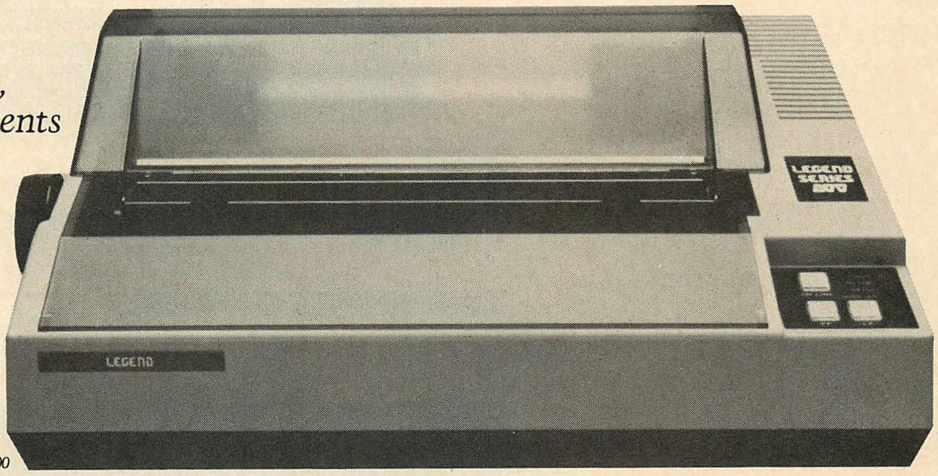
Distributors: **Australia**, Fawnray Pty. Ltd., P.O.B. 224, Hurtsville, NSW 2220 (612) 570-6100; **Japan**, Advanced Data Controls Corp., Chiyoda-ku, Tokyo (03) 263-0383; **United Kingdom**, Real Time Systems, Newcastle upon Tyne, 0632-733131

JMI SOFTWARE CONSULTANTS, INC.
1422 EASTON ROAD • ROSLYN, PA 19001 • 215-657-5660

CIRCLE NO. 200 ON READER SERVICE CARD

TECH RELEASES

Hardware, software, and other developments for the PC



Legend 800

HARDWARE

IBM has introduced the **IBM PC*jr* Color Display,** a low-cost, direct-drive display for graphics and other applications on the IBM PCjr. The display features an 80-column mode that offers higher resolution for text display. $429.

IBM
Entry Systems Division
P.O. Box 2989
Delray Beach, FL 33444
305-241-7614

CIRCLE 498 ON READER SERVICE CARD

IBM has also announced that it has fabricated an experimental computer memory chip capable of storing more than one million bits of information. The experimental chip, called a **one-megabit dynamic random access memory** (DRAM), was made using an extension of IBM's Silicon and Aluminum Metal Oxide Semiconductor (SAMOS) processing technology. It operates with a single-voltage, 5-volt power supply and occupies, with its support circuitry, an area of only 80.85 square millimeters. The high storage density of the new chip (13,025 bits per square millimeter) is derived in part from the use of advanced processing technology. A new processing step that electrically insulates adjacent storage nodes from one another allows them to be placed less than one micrometer apart without creating unwanted electrical effects that would tend to impair chip performance. The time needed to read data out of the chip is 150 nanoseconds. Prices unavailable.

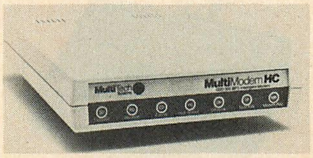
IBM
General Technology Division
Essex Junction, VT 05452
802-769-2890

CIRCLE 497 ON READER SERVICE CARD

A new product from **Multi-Tech Systems,** called **MultiModem,** combines the features of the Hayes Smartmodem 1200 with additional capabilities that enable it to store up to six 31-digit telephone numbers in its battery-backed memory, detect dial and busy tones, and continuously redial a busy telephone number until it connects. MultiModem's use of the Smartmodem 1200 commands makes it compatible with nearly all of the communications software developed for microcomputers. $549.

Multi-Tech Systems
82 Second Avenue S.E.
New Brighton, MN 55112
612-631-3550

CIRCLE 493 ON READER SERVICE CARD



Two new PC boards—the **PERSYST Monochrome Display Adapter Board** and the **PERSYST Color Graphics Display Adapter Board**—have been announced by **Persyst Products.** These boards are intended as alternatives to the IBM PC monochrome and color graphics display adapters. They support all the features of the IBM boards, including (on the monochrome board) a fully compatible parallel printer port with an IBM-compatible light pen interface and (on the color graphics board) two graphics modes, black and white or color modes with 16 colors, and blinking, blanked, and reversed-video character attributes. $295—monochrome board. $244—color graphics board.

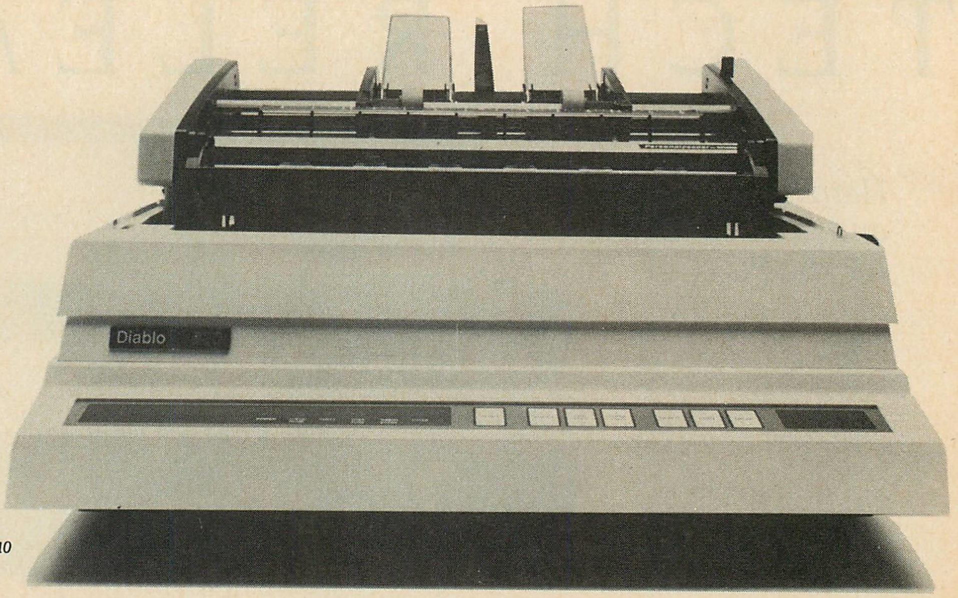
Persyst Products
Personal Systems Technology, Inc.
15801 Rockfield Blvd.
Suite A
Irvine, CA 92714
714-859-8871

CIRCLE 491 ON READER SERVICE CARD

The **Legend 800 matrix printer** from **CAL-ABCO Peripherals Division** is a highly reliable, low-cost, 80-column dot matrix unit capable of bidirectional printing at 80 cps. It features a replaceable print head with a lifetime of more than 30 million characters. The printer has a tested MTBF rating of more than five million lines. Its features include superscript and subscript, double-width (40 columns), compressed print (142 columns), double/compressed print (71 columns), and bold print. The Legend 800 printer uses a unique square print dot. $299.

CAL-ABCO Peripherals Division
14722 Oxnard Street
Van Nuys, CA 91401
818-994-0909

CIRCLE 489 ON READER SERVICE CARD



Model F10

Diablo Systems has announced a new, single-bin mechanical sheet feeder for its Model 620, Model 630 API, and Model 630 ECS daisy wheel printers. The **Model F10** weighs only 7.5 pounds and is easily installed by the operator. The paper tray and output bin each hold 175 sheets of paper in sizes ranging from 6 x 7 inches to 14 x 14 inches. A manual override feed slot permits odd-sized sheets, labels, and envelopes to be loaded without removing the feeder. $495.

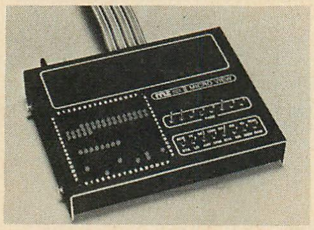
Diablo Systems
901 Page Avenue
P.O. Box 5030
Fremont, CA 94537
415-498-7000

CIRCLE 490 ON READER SERVICE CARD

A new microcomputer debugging aid has been announced by **Micro Logic Corporation. MICRO VIEW** shows micro activity in a convenient real-time graphic format, using a hex-decoded two-dimensional display, MPU bus demultiplexor and selector, conditional data latch, O-X-1 switch comparator, control bus state selector, and reconfigurable personality logic. MICRO VIEW supports many different micros and is small enough to be portable. $749.

Micro Logic Corporation
P.O. Box 174
100 Second Street
Hackensack, NJ 07602
201-342-6518

CIRCLE 485 ON READER SERVICE CARD



Intel Corporation has introduced a peripheral chip that controls and automatically refreshes arrays of NMOS or CMOS 64-kilobit dynamic RAM in microcomputer systems and on memory expansion boards. Fabricated with Intel's complementary high-performance metal-oxide semiconductor (CHMOS) process, the new **82COS dynamic RAM controller** provides low power dissipation, high reliability, and performance equal to or better than current HMOS or NMOS technologies. $35 in quantities of 100.

Intel has also announced the **51C64** and the **51C65,** two new CHMOS 64D dynamic RAMs. These products, the first dynamic RAMs to be produced with CHMOS technology, will store 65,536 bits of information on a chip only 141 mils x 214 mils, or about one-quarter of a square inch. Each product is available in four versions suited for different access times and power consumptions. $15 to $24, depending on the version.

Intel Corporation
2625 Walsh Avenue
Santa Clara, CA 95051
408-496-9630

CIRCLE 488 ON READER SERVICE CARD

The **Helix PC Bubble Disk** from **Helix Laboratories** emulates a "mini-Winchester" hard disk without requiring increased or external power supply. It responds to fixed disk commands under most operating systems, including PC-DOS 2.0, Softech Pascal IV.13, and CP/M-86 for the PC/XT. RESTORE and BACKUP commands, as well as partitioning to hold multiple operating systems, are standard features. The PC Bubble Disk contains four Intel 7110-4 one-megabit bubble memories, providing non-volatile mass memory with no moving parts. Operation is silent. MTBS is greater than 20 years. $1,495.

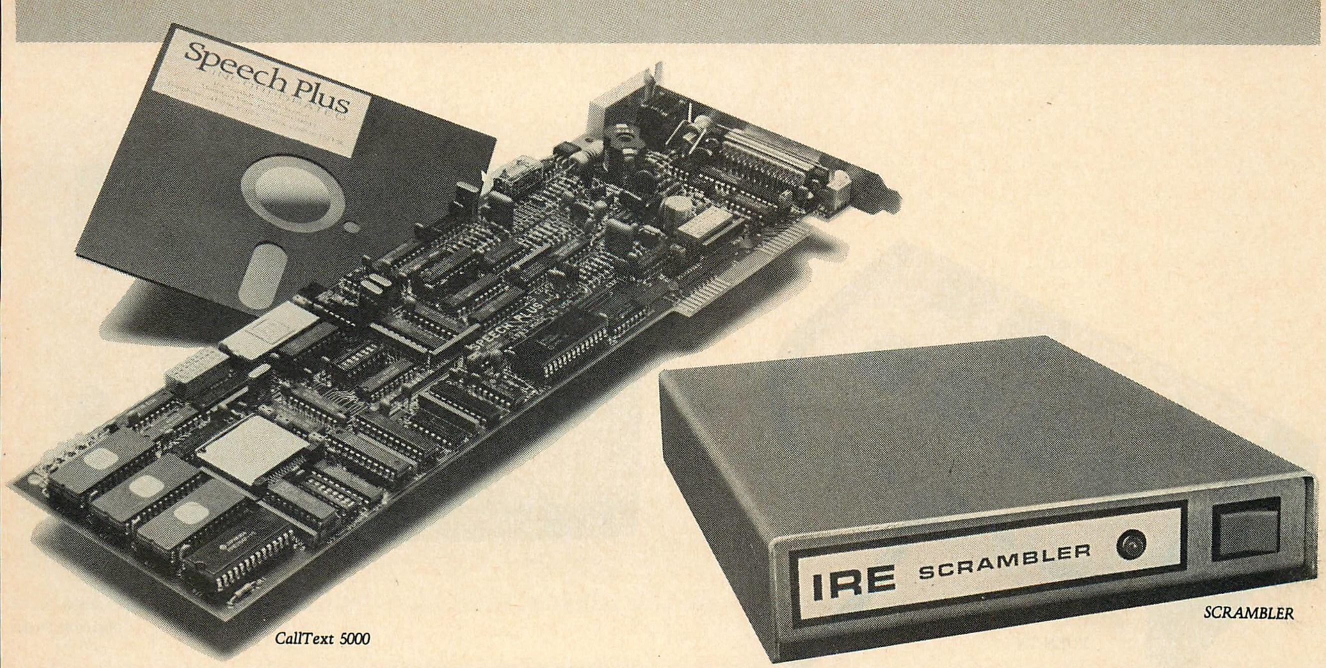
Helix Laboratories
8123-25 Remmet Avenue
Canoga Park, CA 91304
818-710-0300

CIRCLE 492 ON READER SERVICE CARD

A hardware reset button called **PC RESET** has been introduced by **Security Microsystems Consultants.** PC RESET places a reset signal on the PC's microprocessor, causing the microprocessor to be interrupted no matter how badly locked into a program it may be. Security Microsystems Consultants QUICKON module is supplied with PC RESET, allowing the user to bypass the start-up memory tests if desired. $89.95.

Security Microsystems Consultants
16 Flagg Place
Suite 102 PF
Staten Island, NY 10304
212-667-1019

CIRCLE 495 ON READER SERVICE CARD



CallText 5000

SCRAMBLER

AST Research has announced a new local area network for the IBM PC/XT and the PC*jr*—**AST-PCnet II.** This cost-effective system incorporates twisted-pair technology for lower costs and print spooling for increased efficiency. The operation of AST-PCnet is transparent to users, and each PC can be designated either as a shared PC with shareable disk drives or as a user PC, which can access the shared PCs. AST-PCnet uses standard PC-DOS commands to access remote drives and printers, accesses up to 16 floppy, hard, or RAM disk volumes from a user PC, and provides file-record locking and datagram transmission. $1090 for starter kit; $495 for add-on kit.

Also from **AST Research** comes the **MonoGraphPlus,** a graphics board that adds high-resolution and bit-mapped graphics capabilities to the IBM monochrome display. This user-installable enhancement is compatible with Lotus 1-2-3 and other popular programs. $595.

AST Research, Inc.
2121 Alton Avenue
Irvine, CA 92714
714-863-1333

CIRCLE 486 ON READER SERVICE CARD

CallText 5000, from **Speech Plus, Inc.,** is an IBM PC-compatible text-to-speech converter and telephone interface board that enables a user to access text data vocally through any Touch-Tone telephone. CallText 5000 combines a telephone interface with Speech Plus's proprietary text-to-speech technology, providing voice output with unlimited vocabulary for the PC. It can be programmed to answer the telephone, obtain text data from a host computer, and supply text data in voice to the caller. $2700, including interface software.

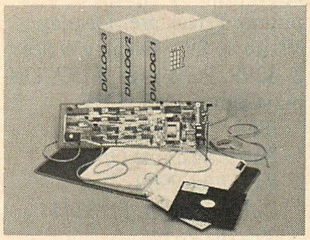
Speech Plus, Inc.
461 North Bernardo Ave.
Mountain View, CA 94043
415-964-7023

CIRCLE 496 ON READER SERVICE CARD

Dialogic Corporation's new **DIALOG** series of voice I/O products for the IBM Personal Computer provides high-quality, real-time voice storage and retrieval for business applications. The DIALOG system also provides a telephone interface, automatic dialing and answering capability, touch-tone decoding, and an on-board modem. The product comes in three configurations: DIALOG/1, which provides the basic voice I/O capability; DIALOG/2, which adds the phone interface, auto-dial and auto-answer firmware, and tone decoding; and DIALOG/3, which includes a 300-baud modem and digital transmission firmware. $295 for DIALOG/1, $495 for DIALOG/2, and $595 for DIALOG/3.

Dialogic Corporation
164 McKinley Avenue
East Hanover, NJ 07936
201-386-0202

CIRCLE 484 ON READER SERVICE CARD

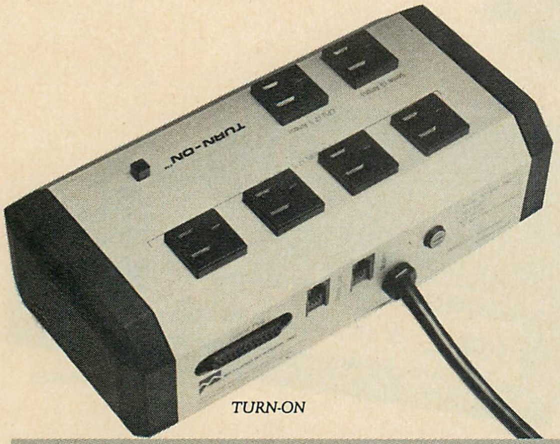


The **SCRAMBLER** encryption device from **Industrial Resource Engineering, Inc.** eliminates third-party intrusions and prevents unauthorized access to confidential files as data are transmitted over public phone lines. Provided in matched sets, SCRAMBLERS are stand-alone devices that are easily installed between the computer and the modem. The units communicate asynchronously over an RS-232-C interface and use the Data Encryption Standard of the National Bureau of Standards. $295.

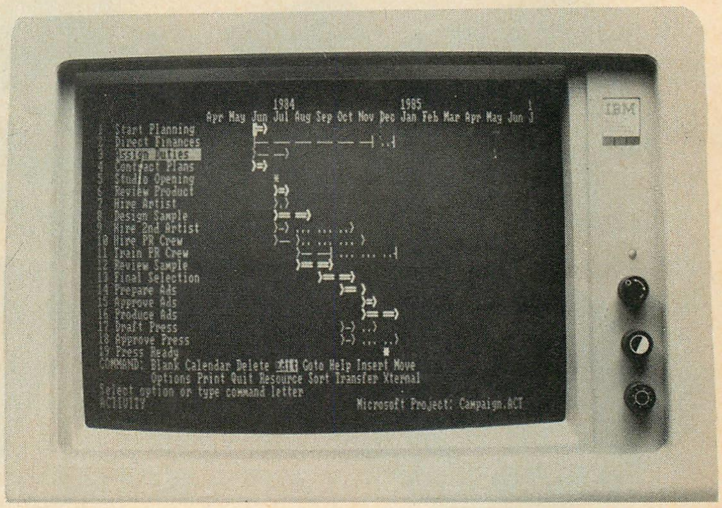
Industrial Resource Engineering, Inc.
P.O. Box 57
Timonium, MD 21093
301-252-1379

CIRCLE 487 ON READER SERVICE CARD

Skyland Systems has announced **TURN-ON,** a power controller designed specifically to allow communications to unattended, remote, powered-down computer systems. TURN-ON will turn on the computer system during an incoming phone call and turn it off again when all file transfers, electronic mail, and other requests have been executed. The power controller is hardware independent and will work with all communications programs and direct-connect modems that can run unattended at the remote end. The remote devices must be able to ini-



TURN-ON



Microsoft Project

tialize and perform unattended access without any manual intervention. $189 for Model 1001, which has basic power spike suppression; $219 for Model 1002, which provides surge and transient suppression.

Skyland Systems, Inc.
150 Green Valley Road
Scotts Valley, CA 95066
408-438-5007

CIRCLE 494 ON READER SERVICE CARD

SOFTWARE

IBM has introduced three word processing programs for the PC. **DisplayWrite 1** is designed for use especially with the PC*jr*, but also can be used with other PCs. Its program/data diskettes, via a conversion utility that is included with the package, can be exchanged with PCs, PC/XTs, and Portable PCs that use **DisplayWrite 2**. This diskette exchange lets documents be created, modified, or printed on different systems, at home or in the office. DisplayWrite 2 is similar to the IBM Displaywriter Textpack 4 licensed program. Among its features is a built-in spelling verification aid of about 100,000 words. A specialized spelling aid of about 16,000 legal terms—known as DisplayWrite Legal Support—is available for use with DisplayWrite 2 for an additional $165.

IBM PCWriter offers menus and commands similar to those of the IBM 5520 administrative system and IBM Datamaster. It includes a dictionary of about 120,000 words.

Also introduced by IBM was **DisplayComm BSC,** a binary synchronous communications program that enables PCs, PC/XTs, and Portables to send DisplayWrite 2 documents to other appropriately equipped computers. Prices are: DisplayWrite 1, $95; DisplayWrite 2, $299; PCWriter, $199; DisplayComm BSC, $375.

IBM
Entry Systems Division
P.O. Box 2989
Delray Beach, FL 33444
305-241-7614

CIRCLE 482 ON READER SERVICE CARD

Recent software releases by **IBM** include new compilers for FORTRAN and Pascal. **FORTRAN Compiler Version 2.0** has the following enhancements over Version 1.0: support for the 8087 math coprocessor; improved arithmetic abilities, including 32-bit arithmetic, double-precision real numbers, and transcendental function support; ability to compile larger programs; addition of list-directed I/O; support for overlays; and support for arrays with up to seven dimensions. **Pascal Compiler Version 2.0** has the same 8087 math coprocessor and arithmetic enhancements and adds support for DOS 2.0 file names and for a long heap, a library manager, and a large linker. Prices are: $350 for FORTRAN Compiler; $350 for Pascal Compiler.

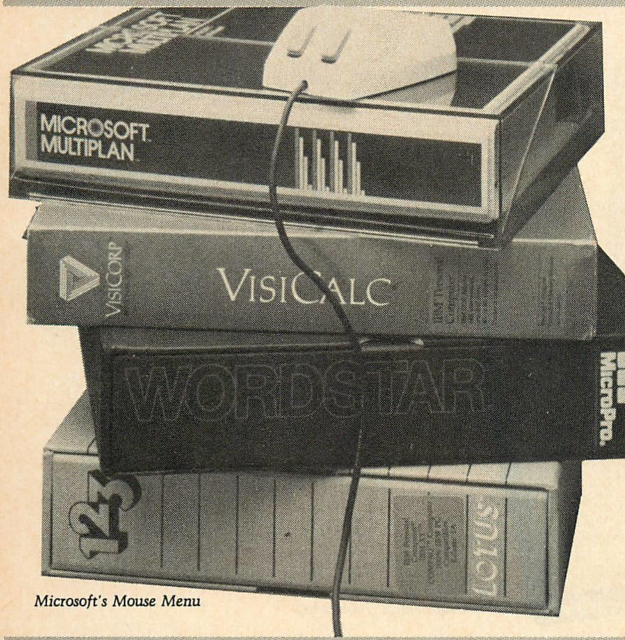
IBM also has introduced **SORT Version 1.0**, which provides data record sorting and merging functions. It is available either as a standalone utility or with IBM COBOL. It supports most BASIC, FORTRAN, COBOL, and Pascal data formats and file organizations, including indexed files, and has multiple sort fields. $175.

Also from IBM are the **Script/PC** text formatter and the **Print Screen Utility Program.** The Script/PC formatter allows creation of professional-looking documents. It will generate a table of contents, index, and footnote entries; format with one or two columns per page; number pages automatically; imbed files; create boxes; choose printer fonts; and allow the user to view a document on screen while formatting and printing. The Print Screen Utility Program is intended for IBM PC owners with an IBM PC Color Printer. With this program the "PrtSc" key may be used to send a screen of text or graphics from the active display buffer to the color printer. $275 for Script/PC; $35 for Print Screen Utility Program.

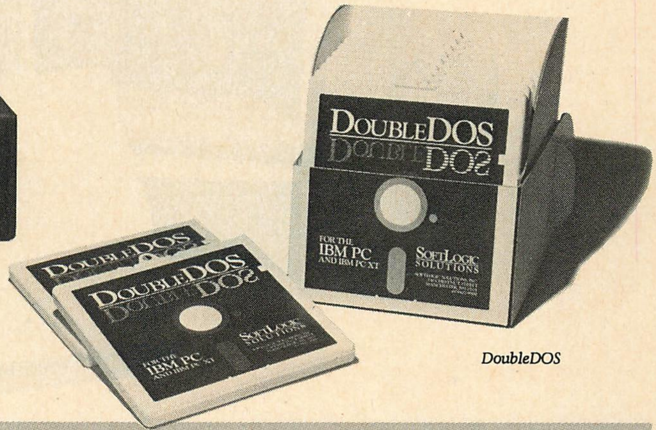
IBM
Information Systems Group
900 King Street
Rye Brook, NY 10573
914-934-4488

CIRCLE 481 ON READER SERVICE CARD

Microsoft has announced a new project-scheduling program for the IBM PC. **Project** is designed to work like a spreadsheet, and it has resource and cost tables, graphic displays of schedules and resource utilization, and extensive reporting abilities.



Microsoft's Mouse Menu



DoubleDOS

Information can be transferred from Project to Microsoft Chart and Multiplan, Lotus 1-2-3, and dBASE II.

Also from **Microsoft** comes a utility program that will permit the use of the Microsoft Mouse with IBM PC application programs that currently have no mouse support, including Microsoft Multiplan, Lotus 1-2-3, WordStar, and VisiCalc. The **Mouse Menu** changes the way a user interacts with an application program by enabling him to use the Microsoft Mouse to initiate all commands that formerly were entered with the keyboard. Microsoft provides the source code listings of the Mouse Menu programs so users can create menus for other programs besides the ones listed. The Mouse Menu software is packaged with the Microsoft Mouse, which sells for $195. For those who already own the Microsoft Mouse, updates are available for $25.

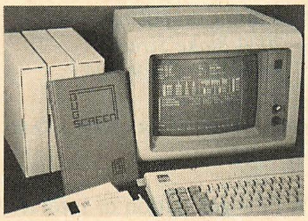
Microsoft
10700 Northrup Way
Bellevue, WA 98004
206-828-8080

CIRCLE 479 ON READER SERVICE CARD

RDT Software, a new company specializing in software development tools, is inaugurating its product line with **Bugscreen,** a symbolic debugger for the IBM PC Macro Assembler. The product features windows for the source listing, the registers and flags, the stack, and selected memory. Changes are highlighted on the screen during execution of the program. Bugscreen can handle data in the form used by the program being tested. $95.

RDT Software
P.O. Box 96634
Weatherford, OK 73096
405-772-1821

CIRCLE 477 ON READER SERVICE CARD



SoftLogic Solutions has announced an improved version of **DoubleDOS** that is compatible with the IBM PC-DOS version 2.1 as well as the older 2.0. DoubleDOS is an operating system enhancer that allows the PC user to run a remote data link, communicate with a host system, or do other communication tasks while the PC is being used for tasks such as word processing, spreadsheet, or data base management. $299.

Softlogic Solutions
530 Chestnut Street
Manchester, NH 03101
603-627-9900

CIRCLE 474 ON READER SERVICE CARD

New software that allows PC users to design or personalize pop-up menus has been introduced by **Mouse Systems Corporation.** Called **Designer Pop-up,** the menu software can be personalized using any word processor that creates ASCII text files and a compiler provided by Mouse Systems. Version 3.00 of Designer Pop-up includes menus that have been preconfigured for use with Lotus 1-2-3, VisiCalc, Multiplan, Personal Editor, Volkswriter, WordStar, SuperCalc 3, Multimate, and PFS:WRITE. $95.

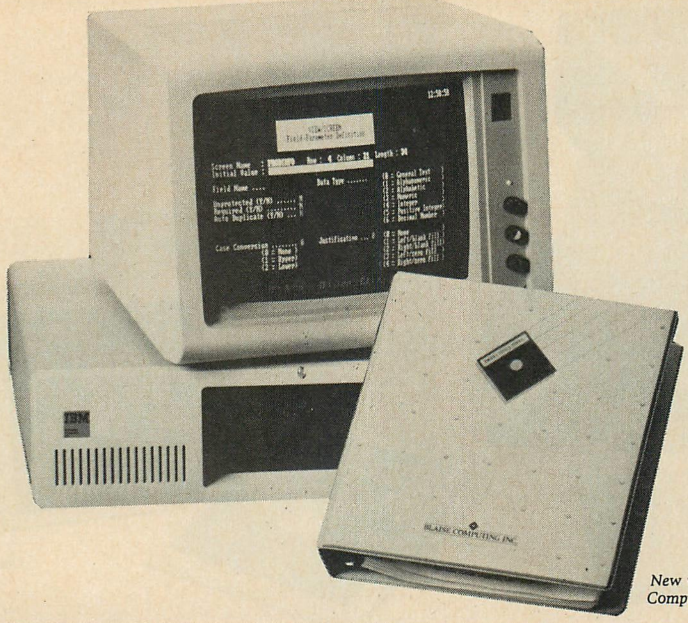
Mouse Systems
Corporation
2336H Walsh Avenue
Santa Clara, CA 95051
408-988-0211

CIRCLE 475 ON READER SERVICE CARD

The last major language not available to the PC user, SNOBOL4, has been implemented for the IBM PC. **Catspaw, Inc.** is offering **SNOBOL4+,** which encompasses all of mainframe SNOBOL4 except FORTRAN output formats. SNOBOL4+ produces concise programs for string, algebraic, and list processing, and all forms of non-numerical computation. In addition to its standard language features; SNOBOL4+ has some extensions: additional string functions and additional real functions are offered; files may be dynamically attached during program execution using file names contained in string variables; standard INPUT and OUTPUT files may be redirected from the command line; ASCII and binary modes of file access are provided; keyboard input may be edited line by line or read character by character, with or without screen echo; optional case-folding allows upper- and lower-case variable and function names to be treated alike. $50.

Catspaw, Inc.
P.O. Box 1123
Salida, CO 81201
303-539-3884

CIRCLE 483 ON READER SERVICE CARD



New versions of Blaise Computing's Pascal Tools series

Pick Systems has announced **PICK PC-XT,** a multi-user PICK operating system for the IBM PC/XT. In addition to virtual memory management, which allows a user to treat the entire disk as main memory, an integral data base manager is embedded in the system. Other features include: variable-length records with up to three dimensions of standard internal delimiting; an English-like inquiry language called ACCESS; PICK/BASIC, a high-level programming language; and a terminal control language known as TCL. $495.

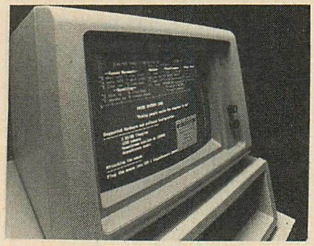
Pick Systems
17851 F Skypark Circle
Irvine, CA 92714
714-261-7425

CIRCLE 469 ON READER SERVICE CARD

Prolog, the logic language used on fifth-generation Japanese computers, has been tailored for use on the IBM PC. **Logic Programming Associates** is producing **micro-PROLOG,** which features two program development systems that allow the use of either an English-style syntax or a LISP-style syntax; more than 70 primitive relations, including integer point and floating point arithmetic, console I/O, random access disk, and formatted record I/O; and extension with new system commands definable by the programmer. $275.

Programming Logic Systems Inc.
31 Crescent Drive
Milford, CT 06460
203-877-7988

CIRCLE 480 ON READER SERVICE CARD



New versions of the Pascal Tools series have been released by its manufacturer, **Blaise Computing, Inc.** In addition to enhancements to functionality, **Pascal Tools Version 2.5** and **Pascal Tools 2 Version 1.2** now include copies of their object code in Microsoft Library format as well as standard object files, making the linking process more efficient. The new versions also have a general text formatter utility and command files that produce print files of the source code. Pascal Tools Version 2.5: $125; Pascal Tools 2 Version 1.2: $100.

Blaise has added another product to its line: **EXEC,** a program-chaining monitor for PC-DOS 2.0. With EXEC, the user can chain programs that are written in different languages. Also, a common data area can be specified to the size necessary to transfer data structures between programs, although only one program is memory-resident at a time. $95.

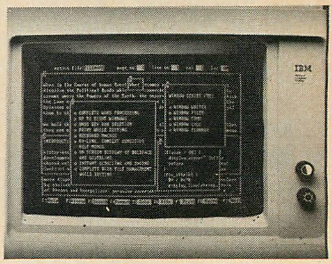
Blaise Computing
2034 Blake Street
Berkeley, CA 94704
415-540-5441

CIRCLE 473 ON READER SERVICE CARD

A new generation of interactive information managers, known as the **Window Series,** enables the user to perform multiple tasks without having to leave the text editor. Data derived from one operation can be shared immediately with any other application. Produced by the **Software Instruments Group,** the series consists of five software packages: **Window Writer,** a word processor that allows up to eight concurrent windows to be displayed; **Window Filer,** a text filer/librarian; **Window Comm,** a data communications facility; **Window Calc,** a spreadsheet and calculator; and **Window Planner,** an event planner/scheduler/calendar. Window Writer is available now for $375; Window Comm: $150; Window Filer: $150. Window Calc and Window Planner are scheduled for release in the third quarter of 1984.

Software Instruments Group
2-1645 E. Cliff Drive
Santa Cruz, CA 95062
408-475-8986

CIRCLE 478 ON READER SERVICE CARD



TECH BOOK A Special Section for Product and Service Listings

COMPUTER/SERVICES

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INTERNATIONAL DOCUMENTATION provides reliable service in the preparation of foreign documentation & mktg. materials. Service includes translation, typesetting, & graphic art. Clear and accurate documentation in any language is a must. Let INTERNATIONAL DOCUMENTATION make your foreign documentation speak for you.
INTERNATIONAL DOCUMENTATION
120 Barranca Ave. Suite A
Santa Barbara, CA 93109
(805) 965-4761/(213) 990-4886

HARDWARE/ADD-ON BOARDS

EPROM & MP PROGRAMMER
PC compatible APROM-2000 card can program 2716, 32, 32A, 64, 128, MCM 68764 EPROMS and also 8748/49/51 processors. The software (CP/M-86, MSDOS) can read, verify and program eproms and uses fast programming algorithm. The zero insertion socket is mounted on an external box. The external box for BI-POLAR proms and PAL is also available.
ADVANCED MICROCOMPUTER
SYSTEMS, INC.
6802 N.W. 20th Ave.
Ft. Lauderdale, FL 33309
305-975-9515

DT2801 SERIES ANALOG I/O
Plug-in data acquisition boards with 8DI/16SE analog inputs, high or low level programmable gains, 2 analog outputs, 16 lines of digital I/O, DMA, on-board clock, and on-board microprocessor. Optional software subroutines and screw terminal panels.
DATA TRANSLATION INC.
100 Locke Drive
Marlboro, MA 01752
(617) 481-3700

256K NO SLOT MEMORY
IBM PC-1 owners. Let us install up to 256K RAM on your EXISTING SYSTEM BOARD using NO SLOTS. We improve your IBM PC so it can address the 64K RAM chip, 256K-$335 (expandable and warranted). DO-IT-YOURSELF KITS—PC-KPC-$69.95 ($99.95 assembled). 64K-RAMS-$5.85 ea.
ADD-MEM
22151 Redwood Rd.
Castro Valley, CA 94546
(415) 886-5443

BOOT PC FROM HARD DISK
FiXT boots from DATAMAC, DAVONG, PEGASUS, PERCOM, GREAT LAKES, others. Adds XT-like BIOS interface for your disk to IBM PC2. Ends need for installable device drivers. DOS 2.0/2.1 reqd. Plug-in installation. Specify disk/controller model with order $70 + $3 shipping. (CA orders add 6%).
GOLDEN BOW SYSTEMS
P.O. Box 3039
San Diego, CA 92103
(619) 298-9349

TOTAL PC INPUT/OUTPUT
Electronic Systems Engineering proudly introduces two extremely versatile input/output adaptors for the PC/XT and compatibles. Both are equipped with fully programmable 64K address decoders for operation anywhere in the I/O space. One is a 24 line parallel port & the other, RS-232C. Price is $139.50 each.
ELECTRONIC SYSTEMS ENGINEERING
P.O. Box 452DTS
Portland, Maine 04112
MC/VISA (207) 773-7778

HARDWARE/PERIPHERALS

PC/STD BUS+ SOFTWARE $119
STD EMULINK is a paralell interface to any STD Bus motherboard for IBM PC with Tecmar baseboard. Comprised of STD Bus card, ribbon Cable+ BASIC drivers. STD EMULINK offers PC user economical link to industrial quality STD Bus I/O boards, [ideal for PROCESS CONTROL & AUTOMATION. Send check or money order.
STD EMULINK
P.O. Box 673
Upton, NY 11973

RATES AND INFORMATION

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Contact: Conference on Parallel Processing, IEEE Computer Society, P.O. Box 639, Silver Spring, MD 20901

August 22-24
1984 ACM Sigmetrics Conference on Measurement and Modeling of Computer Systems
Cambridge, MA
Contact: Association for Computing Machinery, 11 West 42nd Street, New York, NY 10036

SEPTEMBER

September 3-5
IBM System User Show
London
Sponsor: IBM System User Magazine
Contact: EMAP International Exhibitions Ltd., 8 Herbal Hill, London, EC1R 5JB, England

September 6-9
CompuLearn: International Exposition and Conference on Computers in Education
Atlanta, GA
Sponsor: Expoconsul International, Inc. and A Better Way in cooperation with The United Negro College Fund
Contact: Expoconsul International Inc., 55 Princeton-Hightstown Rd, Princeton Junction, NJ 08550

September 11-14
UNIX Systems EXPO/84
Los Angeles
Sponsor: Computer Faire, Inc.
Contact: David Sudkin, 617-965-8350; Alan Kucheck, 415-364-4294

September 12-14
Eurographics '84
Copenhagen
Sponsor: SIGGRAPH
Contact: DIS Congress Service, Linde Alle 48, DK-2720 Vanlose, Copenhagen, Denmark

September 16-20
COMPCON Fall
Arlington, VA
Sponsor: IEEE
Contact: IEEE, P.O. Box 639, Silver Spring, MD 20901

September 20-23
New York/Userfest
New York City
Sponsor: Northeast Expositions
Contact: Northeast Expositions, 617-739-2000

September 24-25
World Conference on Ergonomics in Computer Systems
Los Angeles
Contact: Crispin Littlehales or Rosemarie Burnett, Thomas L. Richmond, Inc., 1350 Avenue of the Americas, New York, NY 10019

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